

Cassin's Auklets, Xantus's Murrelets and Other Crevice-Nesting Seabirds at Santa Barbara Island, California: 2009-10 Surveys



Incubating Cassin's Auklet in nest site #1698 at Pinnacle Point on Santa Barbara Island, 20 March 2010.

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EXECUTIVE SUMMARY

- In 2009-10, the California Institute of Environmental Studies, Channel Islands National Park and Carter Biological Consulting intensified baseline data collection efforts for measuring the benefits of on-going breeding colony restoration for Cassin's Auklets (*Ptychoramphus aleuticus*) and Xantus's Murrelets (*Synthliboramphus hypoleucus*) at Santa Barbara Island (SBI), California. Baseline data and other information were obtained for auklets, murrelets and other crevice-nesting seabird species on the main island (SBI proper) in 2009-10, as well as the nearby offshore islets Sutil Island and Shag Rock in 2009.
- Direct evidence of breeding by Cassin's Auklets was found in five locations on SBI in 2009-10, including: 1) a small colony on Sutil Island (~ 30 pairs); 2) a small colony on Elephant Seal Point (≥ 7 pairs); 3) two nests on the Arch Point North Cliffs; 4) one nest at Pinnacle Point; and 5) one nest on the slopes above Elephant Seal Cove. This represented the first documented breeding by Cassin's Auklets anywhere at SBI since 1994.
- In 2009, we captured and banded a total of 22 Cassin's Auklets in mist nets at Elephant Seal Point (14 birds) and Sutil Island (8 birds). Seven of nine auklets captured in mist nets at Elephant Seal Point in March 2010 had been banded in 2009. Five auklets were captured at-sea off Webster Point (2 birds) and Landing Cove (3 birds) in 2009.
- Greater success documenting breeding and colony attendance by Cassin's Auklets in 2009-10 was likely due to: 1) much greater survey effort earlier in the year compared to 2008; 2) the use of mist-nets at Sutil Island (2009) and Elephant Seal Point (2009-10); and 3) improved prey conditions which likely resulted in increased numbers of breeding auklets, longer colony attendance, and higher reproductive success.
- Total numbers of Xantus's Murrelets observed during round-island spotlight surveys suggested that SBI still hosts the largest colony in California, with an estimated population size of about 321-638 pairs or 642-1,276 breeding birds over the entire island in 2009-10. Round-island spotlight survey counts ranged from 48 to 802 birds in 2009 and 98 to 1,227 birds in 2010.
- With the exception of an anomalous count in April 2009, Xantus's Murrelet spotlight survey counts were consistently high in March-April but dropped markedly in May in both years. Excluding the aberrant low count, spotlight survey counts in March-April were much higher in 2010 (mean = $1,024 \pm 157$ birds; range = 882-1,227; $n = 4$) compared to 2009 (mean = 710 ± 67 birds; range = 645-802 birds; $n = 4$). Limited data are available for reliable assessments of population trends with spotlight surveys alone.
- We located a total of 149 Xantus's Murrelet nest sites (sites active in at least one year) during searches at SBI in 2009-10. A total of 80 murrelet clutches were laid in 75 active nest sites in 2009, compared to 173 clutches in 135 nests sites in 2010. Sequential clutches (*i.e.*, two or more clutches laid in the same site within the same breeding season) were found in five sites in 2009 and 37 sites in 2010.

- The large proportion of unknown clutch fates for Xantus's Murrelets in 2009 (36%, n = 29 of 80 clutches) and 2010 (21%, n = 36 of 173 clutches) indicated our infrequent nest searches and checks were inadequate to obtain reliable monitoring data and estimate hatching success for the full data set. Unknown nest fates were less numerous in the upper island plots monitored regularly by CINP where overall hatching success for nests with known fates was 66% in 2010.
- We used night-lighting in the near-shore waters of Landing Cove to capture 113 Xantus's Murrelets in 2009 and 131 murrelets in 2010. Six previously banded murrelets were recaptured each year, including murrelets banded in 1995 (3 birds) and 1996 (2 birds). One murrelet was captured in a mist net on Elephant Seal Point in 2009.
- Several hundred storm-petrels (*Oceanodroma* spp.) were observed around SBI during a spotlight survey in April 2009, although such large numbers were not seen on other nights (range = 2-25 birds). We found small numbers of Ashy Storm-Petrel (*O. homochroa*) nests in 2009 (n=3) and 2010 (n = 7). No nests hatched in 2009, but five (71%) nests hatched and three chicks fledged in 2010. All storm-petrel nests in sea caves failed due to the presence of Barn Owls (*Tyto alba*) in 2009 and 2010.
- Several Pigeon Guillemot (*Cepphus columba*) nests were found in 2009 (n = 10) and 2010 (n =11), mainly in sea caves on the north shore of the island. These nests provided solid evidence of continued breeding at the southernmost colony for this species.
- Only one Rhinoceros Auklet (*Cerorhinca monocerata*) was observed at SBI in 2009-10, a sub-adult seen during the daytime off Arch Point in April 2009. Presence of this species at SBI during the breeding season suggests breeding may eventually occur.
- We collected abundant evidence of Barn Owls preying on Xantus's Murrelets (minimum = 79 carcasses) from an owl nesting cave near Landing Cove in 2009. Murrelet carcasses and owl pellets containing storm-petrel feathers were found in several other locations around the island in both 2009 and 2010.
- Innovative studies are needed to examine survival/mortality of breeding Xantus's Murrelets to complement Barn Owl studies which began in 2010. We recommend minimally intrusive research techniques, such as: 1) genetic analysis of eggs and eggshell fragments to determine parentage of murrelet clutches laid in particular sites over many breeding seasons, as well as sequential clutches laid in a site within a breeding season; and 2) a pilot study involving the implantation of a Passive Integrated Transponder (PIT) in a small sample (n = 10) of adults that are brooding chicks at nest sites.
- Restoration of Cassin's Auklet colonies that were extirpated from mesa and other habitats on SBI proper in the early 20th century is desirable to encourage development of a larger breeding population with greater sustainability over time. Two major steps in this colony restoration process are: a) retention, growth and expansion of the small auklet colonies that currently exist at SBI; and b) use of social attraction techniques to lure auklets from other colonies that may then attend and establish breeding sites within restored habitats.

ACKNOWLEDGMENTS

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INTRODUCTION

The Santa Barbara Island (SBI) group hosts one of the largest and most diverse assemblages of breeding seabirds in the Southern California Bight (Hunt *et al.* 1979, 1980; Sowls *et al.* 1980, Carter *et al.* 1992). Eleven seabird species have been recorded breeding at SBI since 1975-77 when the first complete surveys were conducted (Hunt *et al.* 1979, 1980), including: Ashy Storm-Petrel (*Oceanodroma homochroa*), Leach's Storm-Petrel (*O. leucorhoa*), Black Storm-Petrel (*O. melania*), Brown Pelican (*Pelecanus occidentalis*), Double-crested Cormorant (*Phalacrocorax auritus*), Brandt's Cormorant (*P. penicillatus*), Pelagic Cormorant (*P. pelagicus*), Western Gull (*Larus occidentalis*), Pigeon Guillemot (*Cepphus columba*), Cassin's Auklet (*Ptychoramphus aleuticus*), and Xantus's Murrelet (*Synthliboramphus hypoleucus*). Rhinoceros Auklets (*Cerorhinca monocerata*) and Tufted Puffins (*Fratercula cirrhata*) also bred at SBI in the late 19th and early 20th centuries but no nests have been found since then (McChesney *et al.* 1995).

Breeding populations of several seabird species declined at SBI in the late 19th and early 20th centuries due to various anthropogenic impacts on the island (*e.g.*, introduced cats, ranching, farming, human disturbance) and at-sea (*e.g.*, oil and organochlorine pollution; see summary in Whitworth *et al.* 2009a). By the 1970s, several species showed partial or complete population recovery in response to reduction or elimination of some anthropogenic impacts after SBI was protected as a national monument in 1938. However, little or no population recovery had occurred for other species, especially Cassin's Auklet, Rhinoceros Auklet, and Tufted Puffin. Xantus's Murrelets have declined since 1976-77 (Carter *et al.* 1992; Whitworth *et al.* 2003a) and this decline appears to be continuing to present (Harvey and Barnes 2009). Changes in breeding habitats (especially a major change in vegetation caused by ranching, farming and introduced grasses), changes in numbers and behavior of natural predators (especially the endemic Deer Mouse *Peromyscus maniculatus elusus* and Barn Owl *Tyto alba*), and long-term changes in prey availability may have prevented recovery for some species and caused more recent decline in Xantus's Murrelets. To date, only the Brown Pelican has been listed as endangered under the U.S. Endangered Species Act, although the species was delisted in 2009 after substantial population recovery. Xantus's Murrelet and Ashy Storm-Petrel are candidate species for possible federal listing. Xantus's Murrelet was listed as a California state threatened species in 2004. Four species that currently breed or formerly bred on SBI are listed as California Species of Special Concern, including: Ashy Storm-Petrel, Black Storm-Petrel, Cassin's Auklet, and Tufted Puffin.

Long-term seabird monitoring at SBI has been conducted since 1985 by Channel Islands National Park (CINP), Point Reyes Bird Observatory, Humboldt State University (HSU), California Institute of Environmental Studies (CIES), University of California, and others. Much monitoring effort has focused on surface-nesting species (Brown Pelican, Double-crested Cormorant, Brandt's Cormorant, and Western Gull) whose population size, timing of breeding, and reproductive success can be monitored effectively with ground or aerial surveys (Lewis *et al.* 1988; Gress 1995; Carter *et al.* 1996, unpubl. data; Capitolo *et al.* 2008). Crevice-nesting Xantus's Murrelets have been monitored annually for reproductive success and timing of breeding (Drost and Lewis 1995; Schwemm and Martin 2005) and periodically for population size (Carter *et al.* 1992, 1997, unpubl. data; Whitworth *et al.* 2003a, 2005a). Other species have not been monitored regularly because: a) they are secretive crevice and burrow nesting species

which are active at the colony primarily at night, nest in largely inaccessible habitats, and require specialized monitoring techniques (*i.e.*, storm-petrels and Cassin's Auklet); or b) they require boat surveys which have been difficult to implement along with other land-based monitoring at this remote location (*i.e.*, Pelagic Cormorants and Pigeon Guillemots).

In 2005, the Montrose Settlements Trustee Council (MSTC) approved a restoration project to enhance breeding habitats for Cassin's Auklets and Xantus's Murrelets on SBI, where populations of these two species have declined considerably and breeding habitats have been greatly altered since the late 19th century (Hunt *et al.* 1979, 1980; Murray *et al.* 1983; Carter *et al.* 1992; Drost and Lewis 1995; McChesney and Tershy 1998; Burkett *et al.* 2003; Whitworth *et al.* 2003a, 2009a; MSRP 2005; Adams 2008, Harvey and Barnes 2009). Restoration of native vegetation in select areas on SBI was identified by the MSTC as the primary restoration technique to be used for these two species. Restoration work in 2007-10 included native plant propagation, outplanting in selected areas and social attraction (*i.e.*, vocalization broadcasting and artificial habitat) for Cassin's Auklets (Harvey and Barnes 2009, L. Harvey, unpubl. data).

MSTC sponsored efforts to assess the status of Cassin's Auklets, Xantus's Murrelets and other seabirds at SBI to ensure that adequate baseline data were gathered in 2007-10 for assessing the long-term benefits of restoration to these species. Of chief concern, a small population of breeding Cassin's Auklets had been found in 1976-77 and 1991 (Hunt *et al.* 1979, 1980; Carter *et al.* 1992) but little evidence of their presence or breeding was gathered since 1991 (Adams 2008; Whitworth *et al.* 2009a). In 2008, CIES, Carter Biological Consulting (CBC), and CINP initiated survey efforts designed to detect the presence of breeding Cassin's Auklets and collect limited baseline data on Xantus's Murrelets and other crevice nesting seabirds. Survey techniques included: 1) nest searches in relatively inaccessible and seldom surveyed seabird breeding habitats in sea caves, offshore rocks, and shoreline and cliff areas; and 2) nocturnal round-island spotlight surveys to count Xantus's Murrelets and possibly Cassin's Auklets attending at-sea congregations in waters adjacent to potential nesting areas. Limited surveys in May 2008 found no evidence of Cassin's Auklets breeding on SBI proper, although breeding areas used in 1991 on SBI and Sutil Island were not visited. More extensive efforts throughout the breeding season were deemed necessary to reliably determine if auklets were present.

With increased funding from MSTC in 2009-10, CIES, CINP and CBC substantially increased survey efforts to better assess status and gather more extensive baseline data on Cassin's Auklets, Xantus's Murrelets and other crevice nesting seabirds at SBI. Nest searches in 2009-10 were conducted over a much longer period and in a wider variety of habitats (including Sutil Island and Shag Rock) than in 2008, while spotlight surveys were conducted more frequently through the breeding season. In addition, other survey techniques were employed, including: 1) at-sea captures and banding of Xantus's Murrelets and Cassin's Auklets; and 2) mist-net captures and banding of Cassin's Auklets. In this report, we present the results of surveys (*i.e.*, nest searches, round-island spotlight surveys, at-sea captures and mist-net captures) at SBI in 2009-10 and provide updated summaries of the current status of Cassin's Auklet, Xantus's Murrelet, Ashy Storm-Petrel and other species at SBI. Results of other surveys conducted at SBI in 2009-10 will be presented in separate reports, including: 1) Ashy Storm-Petrel mist-net captures; 2) morning round-island boat surveys of Pigeon Guillemots and Black Oystercatchers (*Haematopus bachmani*); and 3) diurnal radial seabird surveys and prey sampling.



Figure 1. Satellite image of Santa Barbara Island, showing topography of SBI proper and adjacent locations of Sutil Island and Shag Rock.

METHODS

Study Area

The SBI group (Fig. 1) is the smallest of the eight California Channel Islands and is located approximately 75 km southwest of Los Angeles. The perimeter of SBI proper is generally rocky, rugged and steep. The southwest and north-central sides of the island are particularly high and steep, while the east side has lower rocky cliffs and bluffs. The upper island is composed of a large mesa divided by a ridge extending from Signal Peak to North Peak. Two major offshore rocks, Sutil Island and Shag Rock, and many smaller rocks are found off the west and north sides of SBI, and several sea caves are located along the north side. Living facilities (*i.e.*, staff residence and researcher quarters), a campground, storage facilities and a dock are maintained by CINP, but the island is otherwise uninhabited. Waters surrounding SBI are managed by Channel Islands National Marine Sanctuary (CINMS) (out to 9.7 km [6 miles]), California Department of Fish and Game (out to 4.8 km [3 miles]), and CINP (out to 1.6 km [1 mile]).

Logistics

Field studies at SBI in 2009 were conducted during four trips to the island on 1-8 April, 22-29 April, 13-21 May and 24-27 June. Studies in 2010 were conducted during four trips to the island on 15-24 March, 24-27 April, 3-7 May (“night-lighting” captures only) and 30 May - 2 June. Spotlight surveys and access to offshore rocks, sea caves and shoreline habitats were performed in a 3.8 m Zodiac[®] inflatable craft powered by a 20 hp outboard engine provided to CINP by MSTC. The inflatable craft and personnel were supplied with all required safety equipment. Frequent storms and poor ocean conditions in March-May 2010 prevented some scheduled trips and limited field work, particularly spotlight surveys and nest searches.

We used the CINP vessel *Ocean Ranger* for transportation from Ventura Harbor to SBI on all trips in 2009. The *Ocean Ranger* was also used for the return trip to Ventura on 8 April and 29 April 2009. The CINMS research vessel (R/V) *Shearwater* (Santa Barbara, CA) was used for the return trip to Ventura on 21 May 2009, while the private charter vessel *Retriever* (Ventura, CA) was used on 27 June 2009. Transportation to SBI in 2010 was provided by R/V *Shearwater* on 15 March, the *Retriever* on 24 April and Aspen Helicopters (Oxnard, CA) on 30 May. We used the *Ocean Ranger* for transportation from SBI to Ventura on 24 March and 2 June 2010. Aspen Helicopters was used for the return trip on 27 April 2010. The oceanographic research vessel *Alguita* (Long Beach, CA) was used for transportation to and from SBI on 3-7 May 2010.

Nest Searches

Nest searches for crevice/burrow nesting seabirds (*i.e.*, Cassin’s Auklets, Xantus’s Murrelets, Pigeon Guillemots and Ashy, Black and Leach’s Storm-Petrels) were conducted in a variety of habitats including sea caves, rocky shoreline, offshore rocks and upper island cliffs and slopes on the northern half of the island (Fig. 2). Sea caves, offshore rocks and rocky shoreline habitats were accessible by boat, while upper island habitats were accessible on foot. Nest searches were conducted during each trip (except 3-7 May 2010) although not all areas were searched on each trip (Table 1). Four plots in upper island areas were incorporated into the CINP monitoring program in 2010 and were checked regularly from 6 March to 23 July 2010.

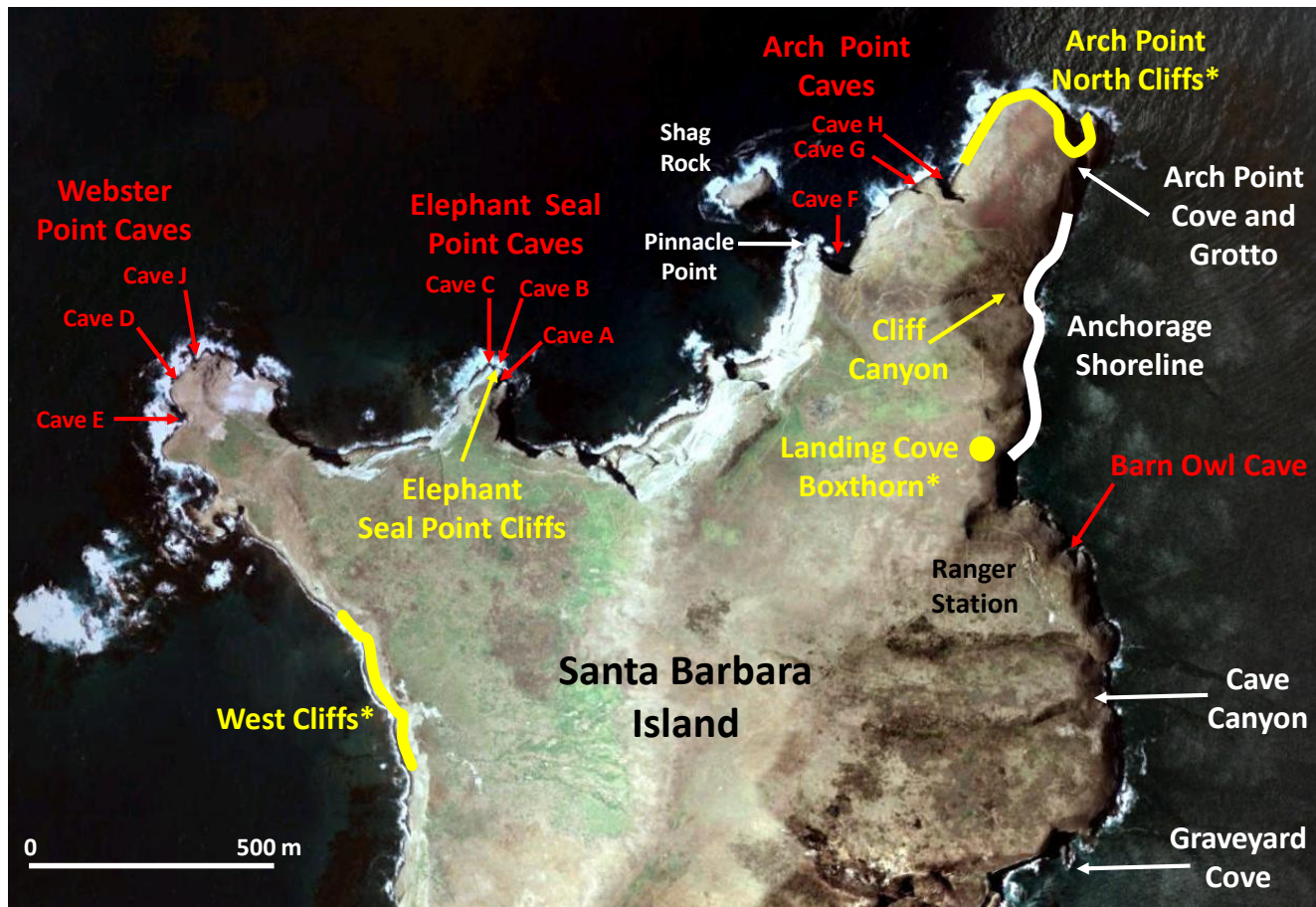


Figure 2. Satellite image of the north end of SBI, with sea cave (red), upper island (yellow), shoreline and offshore rock (white) habitats where nest searches were conducted in 2009-10. Asterisks denote nest plots monitored by Channel Islands National Park.

Table 1. Schedule of nest searches conducted at Santa Barbara Island in 2009-10. Symbols: ● = full check; ○ = partial check; D = not checked to avoid disturbing marine mammals or nesting seabirds; R = inaccessible due to rough seas; P = upper island area incorporated into Channel Islands National Park monitoring program in 2010; N = no check for other reasons.

Habitat	Sea Cave/Plot	2009				2010		
		Early April	Late April	Mid May	Late June	Mid March	Late April	Late May
Sea Cave	Elephant Seal Point A	●	●	●	●	●	●	●
	Elephant Seal Point B-Lower	●	●	●	●	●	●	●
	Elephant Seal Point B-Upper	●	●	●	●	●	●	●
	Elephant Seal Point C	●	●	●	N	●	●	●
	Webster Point D	●	R	●	R	R	R	R
	Webster Point E	●	R	●	R	R	R	R
	Webster Point J	●	R	○	D	○	D	D
	Arch Point F	D	D	●	○	○	D	D
	Arch Point G	●	●			●	R	●
	Arch Point H	●	●	●	●	●	R	●
Shoreline	Barn Owl Cave	●	●	●	D	●	D	D
	Arch Point Cove	●	●	●	D	●	●	●
	Arch Point Grotto	N	●	●	D	●	D	D
	Anchorage	●	●	●	○	●	●	●
	Cave Canyon	D	D	D	D	●	●	●
	Graveyard Cove	●	●	●	N	●	●	●
Offshore Rock	Pinnacle Point	●	●	●	●	●	D	D
	Sutil Island	●	○	N	N	N	N	N
Upper Island	Shag Rock	R	R	●	●	○	D	D
	Arch Point North Cliffs ¹	●	●	●	●	●	P	P
	Elephant Seal Point Cliffs ¹	●	●	●	N	●	P	P
	West Cliffs ¹	●	●	●	N	●	P	P
	Landing Cove Boxthorn ¹	●	●	●	●	●	P	P
	Cliff Canyon	N	N	●	●	N	N	N

¹Plots in upper island areas that were incorporated into CINP monitoring program and checked regularly from 6 March to 23 July 2010.

We used small hand-held flashlights (Fig. 3) to search suitable crevices, sea caves, shrubs and other sheltered sites for evidence of past or current breeding by crevice-nesting seabirds. Evidence of breeding included incubating or brooding adults, whole unattended eggs, broken eggs (eggshell broken into a few larger pieces comprising a complete egg), eggshell fragments (eggshell broken into many small pieces, often scattered and not equaling one complete egg), hatched eggs, eggshell membranes, or chicks. We recorded all observations in field notebooks. Incubating adults were observed briefly with a small flashlight and occasionally photographed (Fig. 3). Incubating Xantus's Murrelets were not handled or prodded to reduce the possibility of clutch abandonment due to researcher disturbance. Cassin's Auklets and Ashy Storm-Petrels are generally more tolerant of minor researcher disturbance than murrelets, so we gently prodded sitting auklets and storm-petrels when possible to determine if an egg was present.

Upon discovery of an occupied nest site, we temporarily marked the site for later identification. Crevice sites were identified by a number written in black ink on a rock at the entrance to the site (Fig. 4), while shrub nests were identified by a small numbered aluminum strip tied to a branch above the nest site (Fig. 4). After nesting activity had ceased in crevice sites, most murrelet and auklet crevice nests were permanently marked by drilling a small hole into the rock near the nest entrance with a masonry drill and inserting a numbered aluminum disc and 10-cm galvanized steel nail. Murrelet nests under shrubs were permanently marked by tying the numbered aluminum disc to a small branch above the nest. In 2009, we did not mark 26 sites for which we could not reliably assess whether eggs were laid in 2009 or a previous year. Only sites containing incubating murrelet adults and a few sites with eggs or eggshell fragments known to have been laid in 2009 were permanently marked for future monitoring. We waited until 2010 to permanently mark several murrelet crevice sites found in sea caves and shoreline plots in 2009 if: 1) incubating adults were present on the last nest check; or 2) conditions prevented us from visiting sites after nesting activity had ceased. In 2009, Ashy Storm-Petrel nest sites were not permanently marked because: 1) we could not monitor storm-petrel nests through the entire breeding season; and 2) drilling might be an unnecessary disturbance to incubating petrels or pre-breeding petrels attending sites. However, temporary markings persisted over many months, allowing these sites to be checked in 2010. CINP began permanent marking of storm-petrel nests found in the monitoring plots in 2010.

CLUTCH FATES – We attempted to determine fates for each Xantus's Murrelet, Cassin's Auklet and Ashy Storm-Petrel clutch discovered in an occupied nest site in 2009-10. Clutches were classified as hatched, failed or unknown based on visible evidence from the nest site contents. A clutch was considered to have successfully hatched only if chicks (Fig. 5) or freshly hatched eggshell fragments (identified by dried membranes that separate from the eggshell, often with visible blood filled veins; Fig. 6) were found in or near a nest site. Because we could not reliably determine clutch size (1-2 eggs; Murray *et al.* 1983) or number of hatched eggs for most murrelet nests, we considered a clutch successfully hatched when at least one chick or one hatched eggshell was found.

Failed clutches were determined by the presence of broken or abandoned eggs in or near an occupied site, or when eggs went missing before the earliest possible hatch date. Most broken eggs were probably depredated or scavenged by deer mice. Depredated eggs were usually identified by the presence of small but visible mouse bite marks on the shell edges (Fig. 7).



Figure 3. Cassin's Auklet incubating a single egg in a crevice site discovered at the base of Pinnacle Point, Santa Barbara Island, 5 April 2009 (Photo by D.L. Whitworth).



Figure 4. Marking methods used to temporarily identify seabird nests at Santa Barbara Island in 2009-10: Xantus's Murrelet in numbered crevice nest in Arch Point Cove, 2 April 2009 (left); Aluminum strip tag attached to bush in the Landing Cove Boxthorn plot, 6 April 2009 (right) (Photos by D.L. Whitworth).



Figure 5. Xantus's Murrelet chicks in a crevice nest in the Arch Point North Cliffs plot, 3 April 2009 (upper); Cassin's Auklet chick from a burrow nest on Sutil Island, 7 April 2009 (lower) (Photos by D.L. Whitworth).



Figure 6. Hatched eggshells of Xantus's Murrelet (left) and Cassin's Auklet (right). Dried membranes with visible veins that separate from the shell are characteristic of hatched eggshells (Photos by D.L. Whitworth).



Figure 7. Xantus's Murrelet eggshell with mouse bite marks on shell edges from a site in the Landing Cove Boxthorn plot, 28 April 2009 (Photo by D.L. Whitworth).

However, it is possible some broken eggs without visible bite marks may have been depredated or scavenged by mice, or damaged during scuffles between adult murrelets competing for nest sites. We could not determine if broken eggs were taken from active nests (with an incubating adult present or when the egg was temporarily neglected) or scavenged after abandonment or adult depredation. Clutches were considered abandoned when whole unattended eggs were observed on at least two consecutive nest checks (about 3-5 weeks).

Hatched eggshells, broken eggs and abandoned eggs were removed from accessible nests after the clutch fate had been determined to prevent any confusion with later clutches laid in that site in that year or subsequent breeding seasons. Because egg neglect can occur in Xantus's Murrelets, unattended eggs were not removed until after two or more nest checks to ensure that eggs were definitely abandoned.

We were unable to determine fates for many murrelet clutches ($n = 29$ in 2009; $n = 36$ in 2010), which in turn prevented us from reliably estimating overall murrelet hatching success for the larger sample in either year due to possible biases (see *Results* and *Discussion*). Also, since we could not determine the number of murrelet chicks that departed from nest sites or their survival at sea, we could not estimate "fledging success" (*i.e.*, the number of chicks surviving to independence) or "reproductive success" (*i.e.*, the number of chicks fledged per breeding pair). When possible, we provide estimates of hatching for Cassin's Auklet and Ashy Storm-Petrel nests found in 2009-10, but these estimates may not be representative of conditions around the island due to the small samples of nests found for each species.

At-Sea Spotlight Surveys

Nocturnal spotlight surveys in near-shore waters were conducted for two main purposes: a) to count Xantus's Murrelets attending at-sea congregations off nesting areas around SBI using a standardized protocol; and b) to search for any Cassin's Auklets attending waters off potential nesting areas around SBI at night. The round-island spotlight survey technique used at SBI in 2009-10 was developed as a line transect at Anacapa and Santa Barbara islands in 2001-02 (Whitworth *et al.* 2003b, c), but was later modified to a strip transect in 2004 to reduce several data collection difficulties, especially in high-density areas (Whitworth *et al.* 2005a). The spotlight survey route circumnavigated SBI (~ 9.5 km) at 200-700 m from shore and followed the same waypoints (Appendix 3) used during earlier surveys at SBI in 2001, 2002, 2004 and 2008 (Fig. 8). Slight deviations from the transect route sometimes occurred when the GPS signal was lost, usually near island peaks and steep high cliffs. In earlier years, "standard" spotlight surveys were conducted along the east side of SBI at 200 m (*i.e.*, "inshore transect") and 500 m (*i.e.*, "offshore transect") from shore. These surveys were not conducted at SBI in 2009-10, but the standard inshore segment formed part of the round-island survey route.

We conducted complete round-island spotlight surveys over seven nights in April-May 2009 and five nights in March-May 2010. Surveys commenced as early as 22:12 h (all times PDT) and as late as 00:06 h, and took 1.0-1.5 h to complete, with the latest survey completed at 01:17 h. Spotlight surveys were conducted in the Zodiac inflatable craft operated by a three-person crew, including a boat driver, spotlight observer, and data recorder. A fourth person on the island maintained periodic radio contact with the survey crew. The driver used a hand-held Garmin

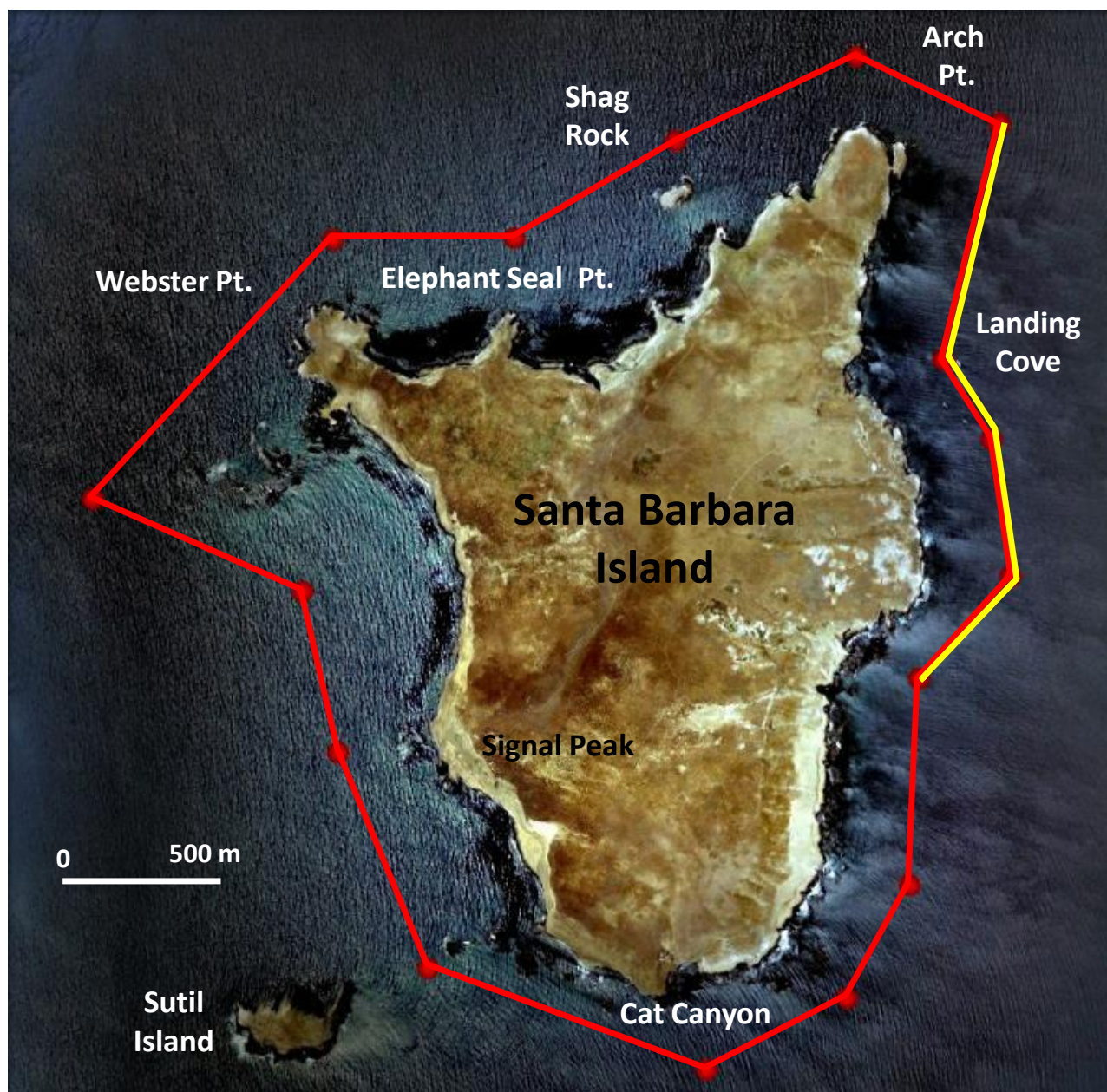


Figure 8. Round-island spotlight survey transect (red line) at Santa Barbara Island in 2009-10. The yellow line indicates the inshore transect of the standard spotlight surveys conducted in 2001-02.

GPSmap 76CS Global Positioning System (GPS) receiver to guide the craft at low speeds along the transect (Fig. 8). Using a high-intensity spot/flood light (1 million candlepower), the observer slowly passed the spotlight beam along the water across a 90° arc on each side of the bow. The observer called off all murrelet (and other alcid and storm-petrel) observations to the data recorder who recorded them in a field notebook. Data recorded included: 1) total number of murrelets and other species seen on the scan; and 2) behaviors (*i.e.*, sitting on water, flying, or flushed) of those birds. All murrelets were included in total survey counts regardless of behavior. The data recorder also entered a GPS waypoint for each observation. Date, time, location, and conditions (*i.e.*, wind, Beaufort sea state, cloud cover, and moon) were recorded at the beginning of the survey and updated when conditions changed.

“Night-Lighting” At-Sea Captures

We used the “night-lighting” technique (Whitworth *et al.* 1997a) to capture Xantus’s Murrelets and small numbers of Cassin’s Auklets over seven nights in 2009 and six nights in 2010. Capture efforts at SBI were focused around Landing Cove, except on the night of 16 May 2009 when captures were conducted off the north and northwest coast of the island, and 25 June 2009 when captures extended south to Graveyard Canyon. We did not attempt night-lighting captures before spotlight surveys were conducted to prevent any possible impacts on survey numbers. In 2009-10, captures and surveys were never conducted on the same night. At-sea capture efforts lasted 1.0-2.5 hrs each night with captures occurring as early as 21:10 h and as late as 02:38 h.

Three-person capture crews (*i.e.*, boat driver, spotlight operator, and dip net handler) searched waters in an inflatable boat while scanning around the craft with high-intensity (1 million candlepower) spotlights for birds attending at-sea congregations. Birds were observed on the water usually alone or in pairs (Fig. 9), although a few larger murrelet groups were seen on occasion. We approached at moderate speeds and attempted to net birds that could be followed with the spotlight as they either remained on the water surface, made shallow escape dives or short flights. Many birds were captured on the first attempt, but multiple attempts were used if the bird remained within spotlight range. Pursuit was ended after a few failed attempts to prevent undue stress to birds.

On most nights, captured birds were transported to the research vessel anchored in Landing Cove for banding and handling. However, on 16 May 2009, 25 June 2009, 30 May 2010 and 1 June 2010, captured birds were banded, handled and released from the inflatable craft at the capture location. Birds handled aboard the anchored research vessel were released off the darkened bow of the vessel. Each bird was: 1) banded with a U.S. Geological Survey #2 incoloy (Xantus’s Murrelet) or #3A incoloy (Cassin’s Auklet) leg band (Fig. 10); and 2) examined for presence and development of bilateral brood patches that are present when birds are actively breeding (Fig. 11). Iris coloration was scored to assist determination of Cassin’s Auklet age class (Manuwal 1978). Xantus’s Murrelets subspecies was identified by facial plumage (Jehl and Bond 1975).

Mist-Net Captures

In 2009, Cassin’s Auklet mist-net captures were conducted over three nights on 23 April, 14 May and 24 June. Mist nets were set up on both Sutil Island and Elephant Seal Point (Fig. 12)



Figure 9. Xantus's Murrelet observed at night in at-sea congregation off Santa Barbara Island, 16 May 2009 (Photo by D.L. Whitworth).

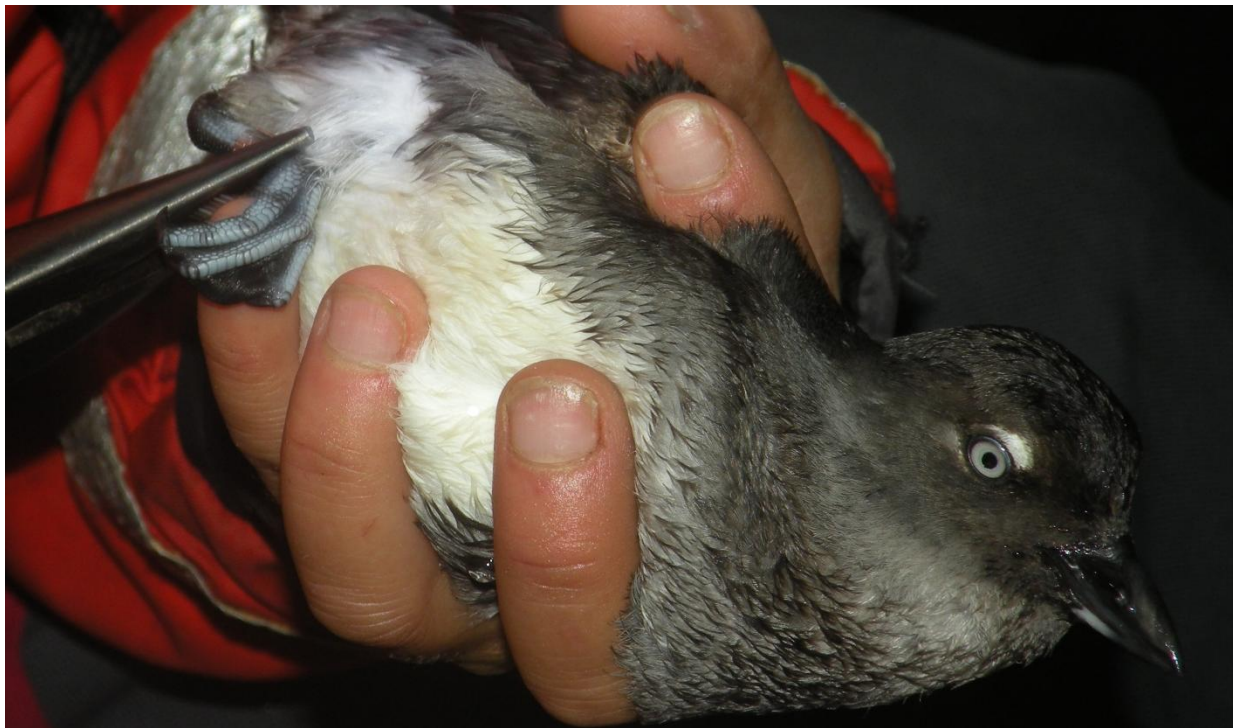


Figure 10. Banding a Cassin's Auklet captured at-sea off Webster Point, Santa Barbara Island, 16 May 2009 (Photo by D.L. Whitworth).



Figure 11. Inspecting a brood patch of a Xantus's Murrelet captured at-sea off the south side of East Anacapa Island, 1 May 2009
(Photo by D.L. Whitworth).



Figure 12. Cassin's Auklet mist-net sites near breeding areas at Sutil Island on 23 April 2009 (above), and Elephant Seal Point on 14 May 2009 (below) (Photos by D.L. Whitworth).

on the night of 23 April, but only the Elephant Seal Point colony was netted on 14 May and 24 June. In 2010, CINP conducted one night of mist-net captures at Elephant Seal Point on 5 March, but the formation of a small Brandt's Cormorant colony prevented further mist-netting efforts there. Mist-net captures were not attempted at Sutil Island in 2010.

At both colonies, we set up 5.5 m (18 ft.) 4-shelf mist nets mounted on anodized aluminum poles in front of large fissures and crevices. At Elephant Seal Point, the mist net was erected at the same location on the north end of the point as used in 1991 to capture auklets or murrelets (Fig. 12). At Sutil Island, mist-net captures for auklets in 2009 occurred on a broad shelf on the lower west side of the island (Fig. 12), and not on the top of the islet where mist-net captures were conducted for storm-petrels and auklets in 1991 and auklets in 2001 (Carter *et al.* 1992; Whitworth *et al.* 2009a; see Appendix 4).

Mist nets were set up prior to dusk and opened after sunset (20:00-21:00 h) to capture auklets as they returned to nests for incubation exchanges or chick feedings. Mist-net capture efforts lasted 4.5-5.0 hrs each night with captures occurring as early as 20:25 h and as late as 00:45 h. We also incidentally captured a few Ashy Storm-Petrels and one Xantus's Murrelet in these mist nets. At Sutil Island, mist-net captures were conducted without playing storm-petrel vocalizations on a CD player whereas, at Elephant Seal Point, a CD player was used. Banding and handling techniques for auklets captured in mist-nets were similar to those captured at sea by night-lighting (*see above*), with the following exceptions: 1) diet samples were collected from chick-feeding adults which regurgitated prey loads during removal from the mist net, banding or other handling; and 2) auklets were weighed at Elephant Seal Point on the night of 24 June 2009 and 5 March 2010.

RESULTS

Nest Searches and Clutch Fates

CASSIN'S AUKLET – During diurnal nest searches in 2009, we found the first direct evidence of breeding by Cassin's Auklets at SBI since 1994, with two active nests on SBI proper (one nest each on the Arch Point North Cliffs #1303 and Pinnacle Point #1698; Fig. 13) and one nest on Sutil Island (Table 2). Mist-net capture of breeding auklets which had brood patches or regurgitated prey for chicks, indicated that at least seven auklet pairs nested in a large crevice near the mist-net site on Elephant Seal Point (Fig.12), but no actual nests were found.

Based on the presence of chicks in all three active auklet nests in 2009, hatching success was 100% for first clutches. Arch Point North Cliff site #1303 contained an auklet chick on 3 April and 25 April, although the age of the chick could not be reliably estimated due to poor visibility into the site. A probable second clutch egg was visible in the site on 14 May and 25 June, but apparently did not hatch. The Pinnacle Point nest site (#1698; Fig. 13) contained an incubating adult on 5 April (Fig. 3), a brooding adult on 22 April, and a medium sized chick on 17 May, but was empty on 25 June. No evidence of dead chicks was found in the two sites on SBI proper that were checked infrequently.

The Sutil Island nest was discovered on 7 April 2009 when a section of the burrow collapsed while we were inspecting a large crevice above the site. A hatched eggshell was seen in the collapsed section of the burrow (Fig. 13) and a brooding adult brooding with a small chick (Fig. 5) was discovered in the back of the burrow as we repaired the site. To avoid further disturbance, we did not check the burrow when we visited Sutil Island to mist net on 23 April. While only one active Cassin's Auklet nest was found on Sutil Island in 2009, we noted about 30 crevices occupied by adults or chicks during nocturnal nest searches near the mist net site on 23 April. Auklets in these sites were visible as they loitered near the crevice entrance at night, but all these sites were too deep to permit monitoring for clutch fates or fledging success.

In 2010, we found four active auklet nests (Table 2). This total includes both nest sites found on SBI proper in 2009, as well as an additional site on the Arch Point North Cliffs (#A6) and a nest site in a rock crevice above Elephant Seal Cove (#A1). The latter site was located in an area where plant restoration began in 2008 (L. Harvey, unpubl. data). The active nest on Sutil Island (Fig. 13) in 2009 was not checked in 2010.

We could not determine hatching or fledging success at Pinnacle Point nest #1698, as a Brandt's Cormorant colony was established there in late March 2010, limiting our observations to one nest check on 20 March. Two clutches (presumably second clutches) were laid in the other three sites on SBI proper in 2010. Hatching success was 66% for first clutches (only the egg in Elephant Seal Cove #A1 failed to hatch) and 100% for second clutches in these nest sites. Chicks were presumed to have fledged from both clutches in Arch Point North Cliff site #1303, but only the second clutch chick fledged in site #A6. We could not determine fledging fates for the first clutch chick in site #A6 or the second clutch chick in site #A1.

In addition to the four active nest sites found on SBI proper in 2009-10, we also discovered: 1) a hatched eggshell below the entrance to a suspected auklet nest site near Elephant Seal Point Cave A on 22 April 2009, but the site was too deep to verify the presence of a chick or brooding adult; and 2) a freshly excavated presumed auklet burrow at Arch Point on 19 March 2010 (Fig. 14), but again the site was too deep to verify the presence of a chick or incubating/brooding adult.

Table 2. Cassin's Auklet nests at Santa Barbara Island, 2009-10.

Sea Cave/Area	2009	2010
Pinnacle Rock	1	1
Arch Point North Cliffs	1	2 (1) ^a
Sutil Island	1 (30) ^b	No Check
Elephant Seal Point A	0 (1) ^c	0
Elephant Seal Cove	0	1
Total	3 (31)	4 (1)

^aOne freshly dug burrow on Arch Point.

^bAbout 30 occupied crevices (adults or chicks at the entrance) were found while mist-netting on 23 April 2009.

^cHatched eggshell found outside a burrow.

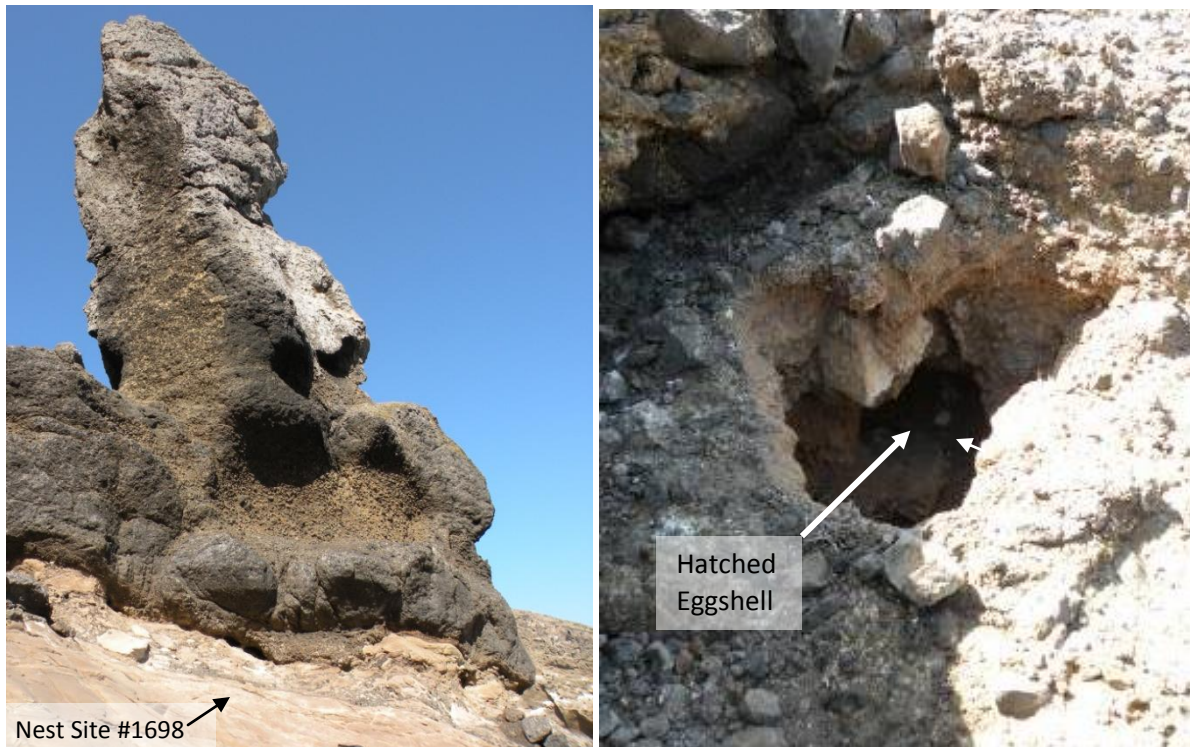


Figure 13. Cassin's Auklet nest site at the base of Pinnacle Point, 5 April 2009 (left); collapsed burrow (with hatched eggshell) on Sutil Island, 7 April 2009 (right) (Photos by D.L. Whitworth).



Figure 14. A freshly excavated Cassin's Auklet burrow on Arch Point, Santa Barbara Island, 19 March 2010. (Photo by D.L. Whitworth).

Despite numerous Xantus's Murrelet remains found at SBI in 2008-10 (*see below*), we found only one Cassin's Auklet carcass during this study, a set of wings from Elephant Seal Point Cave A on 26 April 2010. However, extensive carcass surveys conducted by Simon Fraser University (SFU) and CINP discovered a number of Cassin's Auklet carcasses in scattered areas on the upper island in 2010 (Thomsen and Harvey 2011).

XANTUS'S MURRELET – We found a total of 149 Xantus's Murrelet nest sites (sites with active nests in at least one year) during searches at SBI in 2009-10 (Table 3). Over half (55%) of the sites were found in upper island habitats ($n = 82$), mainly in the Arch Point North Cliffs ($n = 28$), West Cliffs ($n = 25$) and Landing Cove Boxthorn ($n = 25$). An additional 36 sites (24%) were found in shoreline habitats, 29 sites (19%) in sea caves and two sites (1%) on offshore rocks.

A total of 80 murrelet clutches were laid in 75 nest sites in 2009, compared to 173 clutches in 135 nest sites over the same search area in 2010. Fifty-nine sites were active in both years, while 70 sites were active only in 2010 and seven sites (not including two destroyed sites) were active only in 2009. Thirteen sites were not checked adequately in either 2009 or 2010 to determine occupancy that year.

We documented 43 hatched clutches, eight failed clutches and 29 unknown clutch fates in 2009, compared to 89 hatched clutches, 48 failed clutches and 36 unknown clutch fates in 2010 (Table 3). Infrequent nest monitoring in most plots and large numbers of unknown clutch fates, particularly in 2009, prevented an unbiased analysis of hatching success. Unknown nest fates were less numerous in the upper island plots monitored regularly by CINP where overall hatching success for nests with known nest fates was 66% in 2010 (L. Harvey, unpubl. data). Hatching success was 79% in Landing Cove Boxthorn, 65% in Arch Point North Cliffs and 53% in West Cliffs. A detailed analysis of monitoring data in these plots and long-term plot data will be presented in a separate CINP report.

Sequential clutches (*i.e.*, two or more clutches laid sequentially in the same site within the same breeding season) were found in five sites in 2009 and 37 sites (including one site with three sequential clutches) in 2010 (Table 3). In 2009, the later clutches were laid after earlier clutches had hatched ($n = 3$), after the earlier clutch failed ($n = 1$) or had an unknown fate ($n = 1$). Details of hatching success are not yet available for most sequential clutches in 2010, although six later clutches were laid after the earlier clutches hatched ($n = 6$), and only one after the earlier clutch failed. Without banded adults, we could not determine if a later clutch was: 1) a replacement clutch (*i.e.*, laid by the same pair after their early clutch failed or chicks died at sea before independence); 2) a second clutch (*i.e.*, laid by the same pair after successfully raising at least one first clutch chick to independence); or 3) a single clutch laid by a different pair that occupied the site after the first pair had stopped attendance.

In 2009, eggs or eggshell fragments were found in 26 sites where we could not reliably assess whether eggs had been laid in 2009 or in a previous year. Eggshell fragments from past years could easily have accumulated in these sites where nest searches had not been conducted for many years. These 26 sites were not permanently marked and were excluded from nest counts in 2009, although many of these sites were likely marked in 2010 and may have accounted for lower total nest numbers in 2009. We also found 19 hatched or broken eggshells in open

Table 3. Numbers of nest sites and clutch fates for Xantus's Murrelets in sea caves, upper island and shoreline areas, and offshore rocks at Santa Barbara Island in 2009-10.

Area	Total Nest Sites	Active Nest Sites (Clutches) ¹		2009 Clutch Fates			2010 Clutch Fates		
		2009	2010	Hatched	Failed	Unknown	Hatched	Failed	Unknown
Elephant Seal Point A	7	4	5 (6)	0	1	3	4	1	1
Elephant Seal Point B-Lower	6	5	6 (9)	5			5	1	3
Elephant Seal Point B-Upper	5	3	5 (6)	2		1	4	1	1
Elephant Seal Point C	0	0	0						
Webster Point D	0	0	NC ²						
Webster Point E	0	0	NC ²						
Webster Point J	3	3	2 ³	1		2	1		1
Arch Point F	3	3	1 ³	1	1	1			1
Arch Point G	0	0	0						
Arch Point H	3	2	2	1		1			2
Barn Owl Cave	2	2	2 ³	2					2
Sea Cave Subtotal	29	22	23 (28)	12	2	8	14	3	11
Arch Point Cove	17 ⁴	10 (12)	16	4	3	5	6	6	4
Arch Point Grotto ³	3	2	3			2			3
Anchorage	5	4	4		1	3	2	2	
Cave Canyon	6	NC ²	6 (8)				3	2	3
Graveyard Cove	4	1	4	1			1	2	1
Pinnacle Point	1	0	1						1
Shoreline Subtotal	36⁴	17 (19)	34 (36)	5	4	10	12	12	12

Table 3. continued.

Area	Total Nest Sites	Active Nest Sites (Clutches) ¹		2009 Clutch Fates			2010 Clutch Fates		
		2009	2010	Hatched	Failed	Unknown	Hatched	Failed	Unknown
Arch Point North Cliffs	28	9 (11)	27 (39)	6	1	4	22	12	5
Elephant Seal Point Cliffs	2	1 ⁵	1 (2)	1			2		
West Cliffs	26 ⁶	8	25 (39)	5		3	17	15	7
Landing Cove Boxthorn	25	15 (16)	25 (29)	12	1	3	22	6	1
Cliff Canyon	1	1	NC ²	1					
Upper Island Subtotal	82	34 (37)	78 (109)	25	2	10	63	33	13
Sutil Island	1	1	NC ²			1			
Shag Rock	1	1	NC ²	1					
Offshore Rock Subtotal	2	2		1		1			
Annual Total	149	75 (80)	135 (173)	43	8	29	89	48	36

¹Clutches laid by different pairs or second/replacement (*see methods*) clutches occurred in some sites.

²NC = Not checked.

³Sites were not marked or monitored regularly due to potential researcher disturbance.

⁴Total does not include two sites destroyed by rock slide over winter 2009-10.

⁵Site was not checked in 2010 to avoid disturbing cormorants.

⁶One site from 2009 not found in 2010.

locations that were not considered suitable nest sites in 2009, compared to about 10 broken or hatched eggshells in open locations in 2010. We suspect eggshells in open sites were either ejected from crevices by adult murrelets or removed by deer mice.

Abundant evidence of avian depredation on murrelets was found at SBI, particularly in 2009 when carcasses, wings and keels totaling at least 79 murrelets were found in Barn Owl Cave on 13 May (Fig. 15). We had previously removed all carcasses from this cave on 16 May 2008 (when four small Barn Owl chicks were observed in a nest in the upper cave terrace), so all carcasses were taken either late in the 2008 murrelet breeding season or early in the 2009 breeding season. Several large fully feathered Barn Owl chicks were again seen at the cave in April 2009. Small numbers of murrelet carcasses also were found: 1) at the entrance to Arch Point Cave F on 5 April - an extremely fresh kill taken within hours (Fig. 16); 2) in the Arch Point Cove area on 28 April and 13 May - single sets of murrelet wings; and 3) in Elephant Seal Point Cave A on 17 May when a Barn Owl flushed from the cave - two sets of murrelet wings.

We found much less evidence of avian depredation at SBI in 2010, although extensive carcass surveys conducted by SFU and CINP discovered many murrelet carcasses in scattered areas on the upper island (Thomsen and Harvey 2011). We found just two murrelet carcasses and a number of regurgitated owl pellets containing mostly Deer Mouse bones and fur during our only visit to Barn Owl Cave on 20 March. Murrelet carcasses were also found in Elephant Seal Point Cave A on 20 March (one decapitated carcass), 26 April (two heads and two sets of wings) and 31 May (one head). One fresh carcass also was found on the water near Arch Point on 20 March.

ASHY STORM-PETREL – Based on timing of egg laying at Santa Cruz Island in 2009-10 (McIver *et al.*, 2010, 2011), most SBI nest searches were conducted too early in 2009 to detect large numbers of breeding storm-petrels. Regardless, three confirmed nest sites (*i.e.*, adults incubating eggs) were found in Elephant Seal Point Cave A in 2009 (Table 4). None of the confirmed storm-petrel nests successfully hatched in 2009. Broken eggs were observed in two nests, while the egg went missing from the other site. Barn Owls flushed from Elephant Seal Point Cave A on 17 May 2009 (one owl) and again on 25 June (two owls), when we collected about 25 regurgitated owl pellets that contained storm-petrel feathers. We presume that owls preyed upon storm-petrel adults from these nests, and that unattended eggs were later scavenged by mice.

Table 4. Ashy Storm-Petrel nests and potential nests at Santa Barbara Island, 2009-10.

Sea Cave/Area	Nests (Potential Nests) ¹	
	2009	2010
Elephant Seal Point A	3 (3)	1 (1)
Graveyard Cove	0 (0)	0 (1)
Arch Point North Cliffs	0 (1)	6 (1)
Arch Point Cove	0 (1)	0 (1)
Total	3 (5)	7 (4)

¹Nests contained eggs and adults; potential nests contained one or two adults but no visible egg.



Figure 15. Xantus's Murrelet embryo near hatch in a partially eaten egg from Arch Point North Cliffs Nest #1304, 14 May 2009 (left); Xantus's Murrelet carcasses, wings and keels collected from Barn Owl Cave, 13 May 2009 (right) (Photos by D.L. Whitworth).



Figure 16. Fresh Xantus's Murrelet carcass found at the entrance to Arch Point Cave F, on 5 April 2009 (left); Ashy Storm-Petrel attending a nest site in Elephant Seal Point Cave A, on 5 April 2009 (right) (Photos by D.L. Whitworth).

We found seven confirmed storm-petrel nests in 2010 (Table 4). Six storm-petrel nests were found in the Arch Point North Cliffs, but only one of the nests found in Elephant Seal Point Cave A in 2009 was active again in 2010. Five (71%) of the confirmed storm-petrel nests hatched in 2010. All of the hatched nests were located in the Arch Point North Cliffs. One depredated storm-petrel egg was found in an Arch Point North Cliff nest, while the egg went missing from the lone storm-petrel nest found in Elephant Seal Point Cave A. Based on the presence of pellets and storm-petrel feather piles, Barn Owls were again present in this cave in 2010. Observations of fully-feathered chicks indicated that at least three chicks fledged from the five hatched sites, but fledging could not be determined for the other two hatched sites.

Potential storm-petrel nest sites occupied by one or two adults but without visible eggs (Fig. 16) were found in both 2009 (n = 5) and 2010 (n = 4). Potential nest sites were located in Elephant Seal Point Cave A and other widely scattered locations around SBI in both years (Table 4).

PIGEON GUILLEMOT – Several nests and other evidence of breeding by Pigeon Guillemots were found at SBI in 2009-10 (Fig. 17), primarily in sea caves on the north side of the island (Table 5). Most active nests (*i.e.*, crevice sites with eggs, chicks or incubating adults) were found in Elephant Seal Point Cave C in 2009 (n = 5) and 2010 (n = 6). We found only 1-2 nests in the other sea caves and plots. We did not conduct standardized counts, but as many as 35 guillemots flushed when we entered Arch Point Cave H on 5 April 2009 and at least 43 guillemots flushed from Arch Point Caves G and H on 31 May 2010. Despite these large counts of adults, only a few nests were located in these caves but portions of them were not accessible (*i.e.*, wall and ceiling crevices may have contained a few nests), some birds may have had nests in adjacent cliffs or caves, and some birds may not have been breeding.

Table 5. Pigeon Guillemot nests and other evidence of breeding at Santa Barbara Island, 2009-10.

Sea Cave/Area	Nests (broken eggs; hatched eggshells) ¹	
	2009	2010
Elephant Seal Point A	1 (2;1)	1
Elephant Seal Point B (Lower)	1	2
Elephant Seal Point C	5	6
Webster Point E	1	NC ²
Arch Point G	0	2 (1;1)
Arch Point H	1 (2;0)	0
Arch Point North Cliffs	1	0
Arch Point Cove	0 (2;1)	0
Total	10 (6;2)	11 (1;1)

¹Nests occurred in crevices and contained eggs, chicks or incubating adults; other evidence of breeding included broken eggs and hatched eggshells which occurred in open areas which were not considered to be nest sites.

² NC = not checked.



Figure 17. Incubating Pigeon Guillemot in the left arm of Webster Point Cave E, 17 May 2009
(Photo by D.L. Whitworth).



Figure 18. Severely deformed Western Gull egg in a nest site just off the Arch Point Trail at Santa Barbara Island, 14 May 2009 (Photo by D.L. Whitworth).

Adult guillemots incubating eggs were not observed in mid-late May (*i.e.*, 17 May 2009 and 31 May 2010), although two sites with 1-2 eggs were found on 22 April 2010. We could not determine hatching success for most sites, although we observed chicks in two sites on 25 June 2009 and at one site on 31 May 2010.

WESTERN GULL – We did not survey Western Gulls at SBI as part of this study, but population size was estimated by CINP in 2009-10 (L. Harvey, unpubl. data). However, during the course of Xantus's Murrelet nest searches in Cliff Canyon on 14 May 2009, we discovered one severely deformed Western Gull egg (Fig. 18) in a nest just off the Arch Point Trail. No evidence of other eggs was found near the site. Although pollutant analyses were not conducted, the deformed egg was consistent with organochlorine contamination which has greatly affected Western Gulls at SBI in the past, and likely still affects some individuals. The egg was collected and deposited as a specimen (#178911) in the Western Foundation of Vertebrate Zoology.

Spotlight Surveys

XANTUS'S MURRELET – In 2009, round-island spotlight survey counts for Xantus's Murrelets ranged from 802 birds on 7 April to 48 birds during the last survey on 15 May. In 2010, counts ranged from 1,227 birds on 24 April to 98 birds during the last survey on 31 May (Table 6; Appendix 1). Breeding population estimates from maximum spotlight counts each year were calculated with a *k* correction factor which converts bird counts to numbers of nests. Whitworth and Carter (in prep.) were able to calculate a *k* correction factor for Xantus's Murrelets at the northeast portion of SBI in 2001 using the maximum number of murrelets observed during spotlight surveys on the nearshore transect and the number of active murrelet nest sites estimated for the adjacent coastline. The *k* correction factor (0.40-0.52 nests/bird) applied to the maximum round-island survey counts in 2009 (802 murrelets) and 2010 (1,227 murrelets) resulted in population estimates 321-417 pairs in 2009 and 491-638 pairs in 2010. For 2009-10, these estimates were combined to create a joint estimate of 321-638 pairs.

With the exception of 22 April 2009, spotlight counts were consistently high in March-April but dropped markedly in May in both years. On 22 April 2009, an extremely low count (80 murrelets, excluding a chick within a family group) occurred during low overcast conditions with a light mist. These conditions did not appear to reduce visibility for counting compared to other nights, as an unusually large number of storm-petrels (*i.e.*, hundreds) were seen flying at considerable distances from the survey craft. Much higher murrelet numbers (*n* = 707) were obtained two nights later on 24 April (Table 6).

Using only March-April counts (and excluding the anomalous 22 April 2009 count), spotlight survey counts were much higher in 2010 (mean = $1,024 \pm 157$ birds; range = 882-1,227; *n* = 4) compared to 2009 (mean = 710 ± 67 birds; range = 645-802 birds; *n* = 4). Spotlight counts for all March-April surveys conducted in 2010 exceeded the maximum count in 2009. Low coefficients of variation in 2009 (CV = 0.09) and 2010 (CV = 0.15) indicated relatively stable murrelet numbers in March-April (again excluding the anomalous count). Much more frequent surveys are needed to reliably assess nightly trends in numbers attending at-sea congregations.

Most murrelets (87%; *n* = 7,545) were observed sitting on the water, but 11% flushed when first observed and 2% were flying when first observed. Behaviors did not differ greatly among nights,

Table 6. Total counts of Xantus's Murrelets, Cassin's Auklets and other seabirds observed on round-island spotlight surveys at Santa Barbara Island in 2009-10.

Year	Date	Start Time	Xantus's Murrelet	Storm-Petrels	Cassin's Auklet	Pigeon Guillemot	Common Murre
2009	1-2 April	22:49	645	2	0	0	0
	5-6 April	23:55	686	2	0	0	0
	7-8 April	00:06	802	12	0	0	0
	22-23 April	23:50	80	100's	2	0	0
	24-25 April	23:18	707	13	0	0	0
	13-14 May	23:52	382	2	0	3	0
	15-16 May	23:45	48	25	1	0	0
2010	15-16 March	22:21	1,066	0	0	0	0
	22-23 March	22:33	882	0	0	0	0
	24-25 April	22:12	1,227	0	0	0	0
	25-26 April	22:30	922	1	0	0	0
	31 May-1 June	23:10	98	19	0	0	1

except that higher proportions of flying birds (16-21%) and lower proportions of sitting birds (66-75%) were observed on nights when the total count was low (< 100 birds) in 2009. Although murrelet distribution varied somewhat among nights (Appendix 1), birds were present in at least small numbers around most of SBI on most nights. Large murrelet groups were most often seen off the west side near Signal Peak, off the north shore around Shag Rock, off the east shore from Landing Cove south to Graveyard Canyon, and to a lesser extent, immediately off Cat Canyon. The most consistent gap in distribution occurred on the southeast corner, which hosts a relatively large California sea lion (*Zalophus californianus*) haul out and rookery.

ASHY STORM-PETREL – Small to moderate numbers of storm-petrels were observed on each spotlight survey in 2009, but were not observed until the last two surveys (25 April and 31 May) in 2010 (Table 6). Many birds were identified as Ashy Storm-Petrels, but not all birds could be identified to species and some may have been Black or Leach's Storm-Petrels. Small numbers (2-25 storm-petrels) were seen most nights in 2009, except for 22 April when storm petrels were so numerous (several hundred) on the west and north sides of SBI that the storm-petrel count had to be suspended. The low overcast and light mist conditions that affected Xantus's Murrelet attendance of at-sea congregations that night may have created an unusual light scattering that likely attracted more storm-petrels onto the transect or altered their flight behavior.

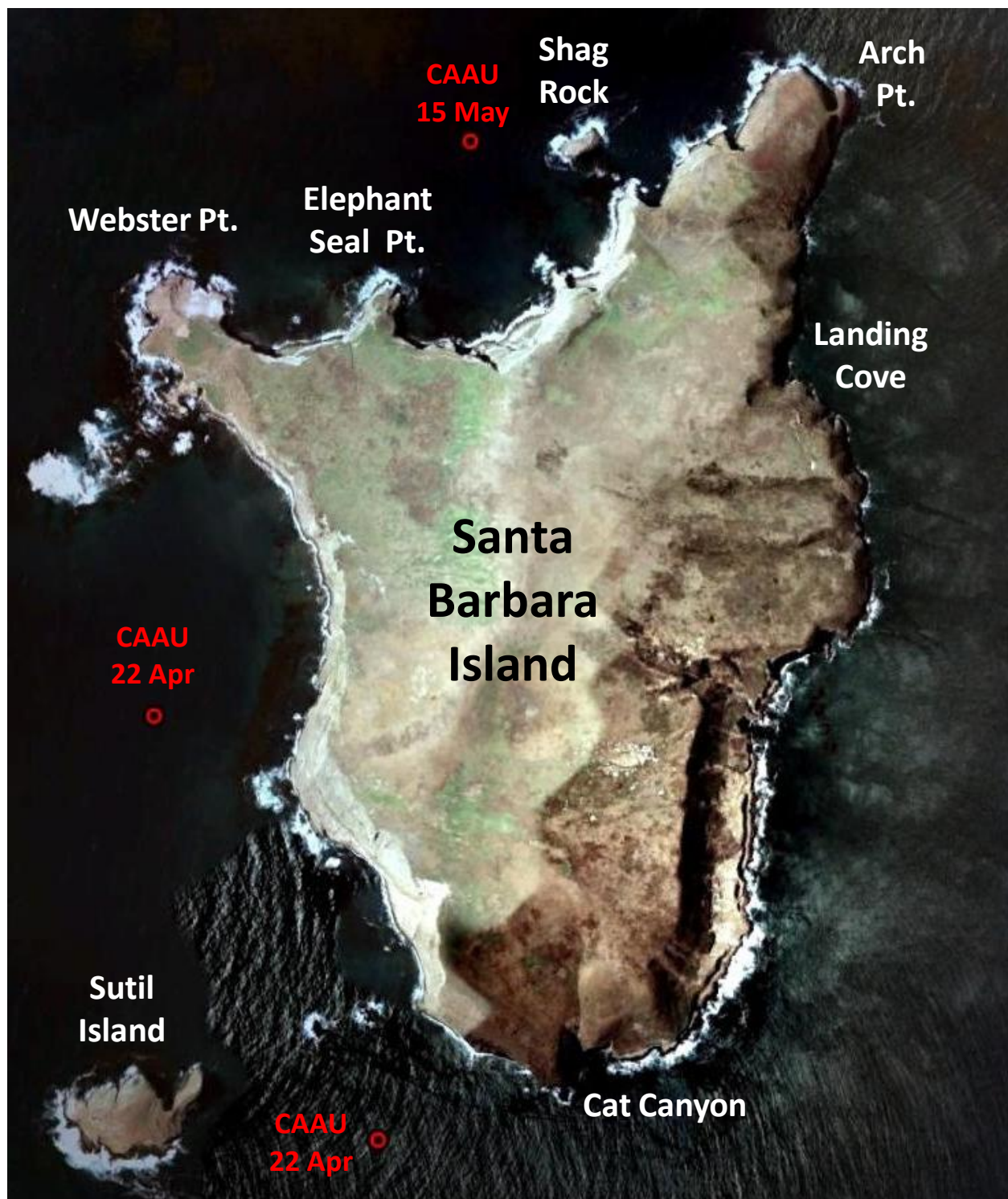


Figure 19. Locations of Cassin's Auklets observed during round-island spotlight surveys at Santa Barbara Island, April-May 2009.

Excluding 22 April, storm-petrels were generally observed singly ($n = 58$) or in “groups” of 2-3 birds ($n = 8$) within the same sweep of the spotlight. Larger groups of up to 4 birds were seen on the east and south sides on 22 April, just prior to suspending the storm-petrel count. Storm-petrels were observed much more frequently along the north shore of SBI in April 2009, but were more widespread around the island in May 2009.

CASSIN’S AUKLET – Only three Cassin’s Auklets were observed in near-shore waters during round-island spotlight surveys in 2009 and none were seen in 2010 (Table 6). In 2009, two auklets were located off the west and southwest sides of SBI on 22 April, while one auklet was located just west of Shag Rock on May 15 (Fig. 19). These areas were roughly adjacent to the largest known breeding areas on Sutil Island and Elephant Seal Point.

PIGEON GUILLEMOT – Pigeon Guillemots were observed in near-shore waters during only one spotlight survey in 2009 (Table 6). A group of three guillemots was seen west of Webster Point on 13 May. Guillemots are rarely encountered on the water off colonies at night.

RHINOCEROS AUKLET AND TUFTED PUFFIN – No Rhinoceros Auklets or Tufted Puffins were seen during round-island spotlight surveys in 2009 or 2010. One sub-adult Rhinoceros Auklet was noted during the daytime on the water near Arch Point on 5 April 2009.

COMMON MURRE – One Common Murre in breeding plumage was observed near Cat Canyon during the round-island spotlight survey on 31 May 2010 (Table 6).

Mist-Net Captures

CASSIN’S AUKLET - We captured and banded 22 Cassin’s Auklets on land in mist-nets over four nights in 2009 (Table 7; Appendix 2). Eight auklets were banded during the single capture night on Sutil Island. Fourteen auklets were banded over three capture nights on SBI proper at Elephant Seal Point. Eight of nine auklets banded at Elephant Seal Point in April were later recaptured; two in May, three in June and three in both May and June. Two of three auklets banded in May were recaptured in June. The mean weight of the ten auklets captured at Elephant Seal Point in June 2009 was 159 g (± 14 *sd*; range = 133-180 g).

We captured nine auklets at Elephant Seal Point on 5 March 2010, the only night of mist-netting that year (Table 7). Mean auklet weight was 166 g (± 12 *sd*; range = 143-182 g). Seven of the auklets captured in 2010 had been banded in 2009. None of the auklets captured in mist nets or at sea in 2009-10 had been banded during previous studies conducted at: 1) SBI in 1991 or 2001 (Carter *et al.* 1992; Whitworth *et al.* 2009a); or 2) Prince Island (San Miguel Island) and Scorpion Rock (Santa Cruz Island) from 1985-2009 (Carter *et al.* 1992; Adams *et al.* 2004; Adams *et al.* 2009; H.R. Carter and J. Adams, unpubl. data).

All 14 auklets banded at Elephant Seal Point in 2009 had developing, fully developed or regressing brood patches, either during the April capture or subsequent recaptures (Table 7). Only three (38%) of eight auklets banded at Sutil Island in April had brood patches; on the same night, eight (89%) of nine auklets banded at Elephant Seal Point had brood patches. In 2010, six (67%) of nine auklets captured at Elephant Seal Point on 5 March had brood patches.

Table 7. Mist-net captures of Cassin's Auklets and Xantus's Murrelets at Santa Barbara Island, 2009-10.

Cassin's Auklets						
Year	Date	Captured	Banded	Recaps	Brood Patches	Location
2009	23 April	8	8	0	3	Sutil Island
	23 April	9	9	0	8	Elephant Seal Point
	14 May	8	3	5	8	Elephant Seal Point
	24 June	10	2	8	10	Elephant Seal Point
2010	5 March	9	2	7	6	Elephant Seal Point
Xantus's Murrelets						
Year	Date	Captured	Banded	Recaps	Brood Patches	Location
2009	14 May	1	1	0	1	Elephant Seal Point

In 2009, eighteen (51%) of 35 auklets regurgitated chick prey loads from gular pouches while in the mist net or during subsequent handling and banding, including: a) two (67%) of three auklets with brood patches at Sutil Island in April; b) four (50%) of eight auklets with brood patches at Elephant Seal Point in April; c) three (38%) of eight with brood patches at Elephant Seal Point in May; and d) nine (90%) of ten with brood patches at Elephant Seal Point in June. Three banded individuals regurgitated prey loads in April and May ($n = 1$) or April and June ($n = 2$). We collected 14 regurgitated prey loads for diet analyses from auklets in April ($n = 5$), May ($n = 3$) or June ($n = 6$). None captured at-sea regurgitated prey loads. In 2010, only three (33%, $n = 9$) of the auklets captured at Elephant Seal Point on 5 March regurgitated prey loads.

At Elephant Seal Point in 2009-10, auklets were captured as they entered or departed from a large fissure (Fig. 12). Captured birds alone accounted for a minimum of seven nests in 2009, if both parents were captured. Unfortunately, we could not determine the number of potential or occupied nest crevices inside this large fissure because it narrowed considerably beyond the entrance so that most of its interior could not be inspected with flashlights. Several other birds evaded capture when entering and departing from the fissure, as the mist net did not completely cover the fissure entrance. Mist-net captures also did not occur during most of the early part of the breeding season in 2009. Given that roughly half of captured adults on 23 April 2009 were feeding chicks (based on regurgitations and regressing brood patches), we estimated that many eggs were laid in February (given about 38 days for incubation and about 40-50 days for chick rearing; Manuwal and Thoreson 1993).

At Sutil Island in 2009, we found a much smaller proportion of breeding auklets with brood patches or prey loads compared to auklets captured at Elephant Seal Point on the same night (Table 7). However, iris coloration scores of 1 ($n = 6$) or 2 ($n = 2$) indicated all these birds were probably adults. Nest searches around the mist net site found an estimated 30 crevice nests occupied by auklet chicks or adults. Many of these sites were outside the large fissure covered by the mist net, such that auklets entering or leaving these sites would not have been captured in the net. Numbers of auklets nesting on other parts of Sutil Island in 2009 were not determined, but many were heard calling from inaccessible cliffs north of the mist site on the northwest face of the island.

XANTUS'S MURRELET – We captured one Xantus's Murrelet in a mist-net at Elephant Seal Point on 14 May 2009 (Table 7; Appendix 2). This murrelet had a fully developed bare brood patch.

At-Sea Captures

XANTUS'S MURRELET - We used night-lighting to capture 113 Xantus's Murrelets at SBI in 2009 and 131 murrelets in 2010 (Table 8; Appendix 2). We banded 106 murrelets in 2009 and 125 murrelets in 2010. Twelve previously banded birds were recaptured, six each year. One murrelet was captured on 25 April 2009 but was released without a band, after a long handling period caused by removal of a poorly fitted band.

With the exception of single murrelets captured on 16 May 2009 off Webster Point and 25 June 2009 off Graveyard Canyon, all murrelets were captured from Landing Cove and the surrounding anchorage. The murrelet captured off Webster Point was one from a pair of the *hypoleucus* subspecies (Fig. 20) seen about 1 km off the island, the only individuals of this subspecies seen near SBI in 2009-10. All other murrelets seen and captured at SBI were of the *scrippsi* subspecies (Birt *et al.*, in review).

Four murrelets originally banded at SBI in 1995 ($n = 2$) or 1996 ($n = 2$) were recaptured at-sea in 2009 (Table 8), while one murrelet banded at SBI in 1995 and recaptured in 1996 was recaptured again in 2010 (Whitworth *et al.* 1997c, 2000, unpubl. data). In 2009, two murrelets were recaptured the night after being banded. In 2010 one murrelet was recaptured nearly a month after being banded. Four murrelets banded in 2009 were recaptured in 2010.

Brood patches were found on 28 murrelets captured at sea in 2009 and 13 murrelets in 2010 (Table 8). Only 2% of the murrelets captured at sea in April 2009 ($n = 52$; excluding one murrelet captured on consecutive nights) and March 2010 ($n = 53$) had brood patches. In contrast, 47% of the murrelets captured at sea in May 2009 ($n = 58$) and 15% of the murrelets captured in May/June 2010 ($n = 78$) had brood patches.

CASSIN'S AUKLET - We captured five Cassin's Auklets at-sea by night-lighting, all in 2009 (Table 8; Appendix 2). Two auklets were captured at sea about 1 km northwest of Webster Point on the night of 16 May, while single auklets were captured in Landing Cove on 16, 18 and 19 May. Four (80%) of the auklets captured at sea in 2009 had brood patches. None of the auklets captured at sea in 2009 were recaptured.

Table 8. At-sea captures of Xantus's Murrelets and Cassin's Auklets at Santa Barbara Island, 2009-10.

Xantus's Murrelets						
Year	Night	Captured	Banded	Recaps (Year Banded)	Brood Patches	Location
2009	25 April	26	24	1 (1996)	0	Landing Cove
	26 April	27	25	2 (1996, 2009)	1	Landing Cove
	16 May	1	1 ¹	0	0	Webster Point
	18 May	15	14	1 (1995)	10	Landing Cove
	19 May	20	19	1 (1995)	11	Landing Cove
	20 May	23	22	1 (2009)	6	Landing Cove
	25 June	1	1	0	0	Graveyard Canyon
Total		113	106	6	28	
2010	15 March	38	37	1 (2009)	0	Landing Cove
	16 March	15	15	0	1	Landing Cove
	3 May	36	34	2 (both 2009)	5	Landing Cove
	5 May	19	17	2 (1995, 2009)	2	Landing Cove
	30 May	7	7 ²	0	2	Landing Cove
	1 June	16	15	1 (2010)	3	Landing Cove
Total		131	125	6	13	
Cassin's Auklets						
Year	Date	Captured	Banded	Recaps	Brood Patches	Location
2009	16 May	2	2	0	2	Webster Point
	16 May	1	1	0	0	Landing Cove
	18 May	1	1	0	1	Landing Cove
	19 May	1	1	0	1	Landing Cove
Total		5	5	0	4	

¹ *S.h. hypoleucus*

² Includes 2 chicks and parent



Figure 20. The *hypoleucus* subspecies of Xantus's Murrelet captured at-sea about 1 km off Webster Point, Santa Barbara Island, 16 May 2009. (Photo by D.L. Whitworth).

DISCUSSION

Cassin's Auklet

Increased survey effort in 2009 resulted in the discovery of small numbers of Cassin's Auklets breeding in four locations on SBI proper, the first documented auklet nesting on SBI since 1994 (Whitworth *et al.* 2009a). These active colonies in scattered areas on SBI proper and nearby Sutil Island could greatly facilitate population growth and colony expansion into restored areas of the island, assuming that favorable foraging conditions continue. However, given the small size of the current breeding population (about 200-250 breeding birds or 100-125 breeding pairs; Hunt *et al.* 1979; Carter *et al.* 1992), much concern about the continued existence of this small colony exists until a larger colony has been redeveloped (Whitworth *et al.* 2009a). The degree of breeding at the SBI colony needs further investigation and continued annual monitoring is necessary to document future population trends. In particular, it is desirable to determine if: (1)

nests can be monitored with the aid of burrow scopes or cameras; (2) other pockets of breeding auklets can be discovered with additional nocturnal nest searches, especially on the upper parts of Sutil Island; and (3) short- or long-term cessation of egg laying occurs in poor prey years or whether egg laying is attempted by at least part of the population each year regardless of prey conditions.

Based on comparisons with 1976-77 and 1991 data, a remnant population of breeding auklets may have persisted at reduced levels on SBI since 1976-77 (Appendix 4) but likely was overlooked during brief and limited surveys in April 2001 (Sutil Island) and May 2008 (SBI proper, but not Elephant Seal Point; Whitworth *et al.* 2009a). In May 2008, our only observation of auklets near SBI was two birds seen from the R/V *Shearwater* 2-3 km north of the island on 14 May. The lack of evidence for breeding at SBI in 2008 likely reflected inadequate surveys, although lower nesting effort or a lack of breeding also may have occurred. Overall, a much lower and later survey effort occurred in 2008 (1 week in mid-May) than in 2009 (3.5 weeks in April-June 2009) and 2010 (3.0 weeks in March-June 2010). Furthermore, while we had conducted extensive diurnal nest searches in many accessible habitats on SBI proper and Sutil Island in 2008, the main nesting area on SBI proper at Elephant Seal Point was not examined (Appendix 4). Breeding Brandt's Cormorants prevented nest searches at: a) Elephant Seal Point, the primary location on SBI proper where auklets had been detected in 1977, 1991, and 1994 (Whitworth *et al.* 2009a); and b) Pinnacle Point, where an auklet nest was found in 2009 and 2010. In 2008, we were not able to visit any prior or suspected nesting areas to detect breeding auklets at night when they would be much more conspicuous. Thorough daytime inspection of the crevice nesting habitat on Sutil Island in 2008 and 2009 resulted in only one active nest site (with chick) found on 7 April 2009 when the burrow collapsed. However, using nocturnal techniques we found abundant evidence of breeding during nest searches and mist net captures on Sutil Island just two weeks later.

Considering our limited survey effort in 2008, a small population of breeding auklets may have: 1) been overlooked during surveys; 2) finished breeding before we started surveys (although data from auklet colonies at Scorpion Rock and Prince Island suggests that auklet nesting extended through May and June, respectively in 2008 [Adams *et al.* 2009]); or 3) foregone breeding (Whitworth *et al.* 2009a). The extended period of poor foraging conditions that has recently contributed to population decline and periodic cessation of breeding activity at other southern California auklet colonies since at least 2000 (Adams 2008; Adams *et al.* 2009) may have continued into 2008 at SBI. Low auklet nesting effort and complete reproductive failure were observed at Prince Island and Scorpion Rock in 2006-07, although breeding improved markedly at these locations in 2008 (Adams *et al.* 2009).

Excellent foraging conditions near SBI in 2009-10 likely contributed to increased numbers of breeding birds or a resumption of breeding, which greatly facilitated our ability to detect auklets at the colony. Cassin's Auklets may be unique among the Alcidae in their ability to raise more than one brood within a breeding season (Manuwal 1979), although second clutches are laid only in the southern portion of their range and only under optimal foraging conditions (*i.e.*, "cold water" years when breeding commences early; Ainley *et al.* 1990). In 2009, probable second clutches were detected during nest monitoring on the Arch Point North Cliffs (Nest #1303; *see Results*) and during mist-net captures at Elephant Seal Point where two auklets that regurgitated

chick prey loads on 23 April and 24 June (a span of 61 days) likely raised second broods (the mean chick feeding period for auklets is only 42 days; Manuwal 1974). In 2010, second clutches were documented in three active auklet nest sites on SBI proper. Second clutches by Cassin's Auklets in 2009-10 were also recorded at Anacapa Island (Whitworth *et al.* 2009b, in prep.), Scorpion Rock and Prince Island (J. Adams, pers. comm.), indicating excellent breeding and foraging conditions for auklets throughout the Southern California Bight in 2009. Preliminary results of seabird transects, prey sampling and oceanographic surveys indicated abundant prey around SBI in 2009-10 (Karnovsky *et al.*, in prep.). These data will be useful for identifying conditions that favor auklet breeding at SBI and for comparison with surveys in the future when poor prey availability associated with El Niño conditions occur.

Bimonthly nest searches conducted throughout the 2008-10 breeding seasons by CINP did not find evidence of auklets breeding in habitats undergoing plant restoration ("restoration area") located on the slopes above Landing Cove, although the auklet social attraction system may have been deployed too late in January 2009 to encourage new breeders to attend the restoration area in 2009. However, three birds captured on the water within hearing range of the speaker system in 2009 and several auklet carcasses found near the broadcast system in 2010 suggested that auklets may have been attracted by the vocalizations. Despite numerous at-sea capture efforts in Landing Cove from 1994-2004 and many spotlight surveys in 2001-04, Cassin's Auklets had not been noted on the water at night in Landing Cove between 1994 and 2009 (McChesney *et al.* 1995; Whitworth *et al.* 2009a; D.L. Whitworth and H.R. Carter, unpubl. data). Additional nest searches in the Landing Cove restoration area began in mid-December 2009, when artificial burrows were installed to facilitate nesting and monitoring (L. Harvey, unpubl. data).

Cassin's Auklets typically do not congregate in near-shore waters off colonies at night, although individuals have been recorded on occasion off many auklet colonies in southern California and northwestern Baja California during spotlight surveys (Whitworth *et al.* 2005a, unpubl. data; Carter *et al.* 2006a, 2006b, 2008). Thus, at-sea captures and spotlight surveys were less useful for detecting numbers of Cassin's Auklets attending the SBI colony and their breeding activities, but did provide limited evidence of auklet presence at the colony. If current or restored nesting habitats are blocked by nesting Brandt's Cormorants or Brown Pelicans, data from at-sea captures and spotlight surveys may show continued presence at the colony.

Xantus's Murrelet

SPOTLIGHT SURVEYS—Total numbers of Xantus's Murrelets observed on spotlight surveys in 2009 and 2010 suggested that SBI still hosts the largest colony in southern California, even though numbers of active nests in monitored plots have declined since 1991 and likely earlier (Carter *et al.* 1992; Drost and Lewis 1995; Whitworth *et al.* 2003a; Schwemm *et al.* 2005; Harvey and Barnes 2009; CINP, unpubl. data). The maximum round-island survey count at SBI in 2009 (n = 802 murrelets) and 2010 (n = 1,227 murrelets) far exceeded counts from other southern California islands, although comparable numbers of surveys within one breeding season have been conducted only at Anacapa Island in 2001-04 (maximum 564 birds in 2004; Whitworth *et al.* 2003b, 2005a). Only a few preliminary surveys have been conducted at Santa Cruz Island (n = 353 birds in 2004), Santa Catalina Island (n = 101 birds in 2004), San Miguel Island (n = 23 birds in 2007), and San Clemente Island (n = 15 birds in 2008; Whitworth *et al.* 2005a; Carter *et*

al. 2008, 2009). However, colonies as large as or larger than SBI exist at the Coronado Islands and Guadalupe Island in northwestern Baja California (Burkett *et al.* 2003, Whitworth *et al.* 2003d; H. Carter and D. Whitworth, unpubl. data).

The population estimate of 491-638 breeding pairs (or 982-1,276 breeding birds) from the maximum round-island survey count at SBI (including Sutil Island and Shag Rock) in 2010 was near the lower end of the range of the most recent population estimate for 1991-2002 (500-800 breeding pairs; Burkett *et al.* 2003), but somewhat lower than a previous estimate for 1991 alone (772 breeding pairs; Carter *et al.* 1992), and much lower than estimates from mid 1970's (1,090-2,090 pairs [Hunt *et al.* 1979] and 10,000 birds [Murray *et al.* 1983]). Caution should be taken when comparing the 2009-10, 1991 and 1977 population estimates because estimation techniques for all three differed markedly and there can be relatively high annual variation (*e.g.*, 2009 versus 2010), making direct comparisons impossible. Carter *et al.* (1992) tried to determine a standardized population estimate by conducting nest searches in all accessible upper-island and coastline habitats on SBI, estimating the number of potential nest sites in inaccessible habitats, and extrapolating occupancy rates (derived from plot data) for potential crevice and bush sites over the entire island (including Sutil Island and Shag Rock). Burkett *et al.* (2003) used a rough estimate provided by HSU (H. Carter, unpubl. data) that was based on interpretation of available knowledge in 1991-2002 of nesting habitats, nest searches, nest monitoring, and numbers of birds attending at-sea congregations. Earlier surveys in the mid 1970's provided higher SBI population estimates of 1,090-2,090 pairs (Hunt *et al.* 1979) and 10,000 birds (Murray *et al.* 1983), although the latter value was not specified as a breeding population estimate. Again, estimates were not comparable within the 1970s and between the 1970s and 1991 due to the different techniques used (which were not designed or intended to be easily repeatable) and the lack of a satisfactory technique for monitoring population changes. The lower estimate was the result of 1977 nest searches throughout upper-island habitats (including SBI proper, Sutil Island and Shag Rock), while the higher estimate was based on murrelet at-sea densities recorded on 1975-77 radial at-sea transects with extrapolation out to 18.5 km around SBI. The latter technique is invalid for several key reasons, including: 1) surveys extended only 18.5 km from SBI, thus did not account for SBI murrelets foraging much farther from the island (see Whitworth *et al.* 2000); 2) surveys may have included significant numbers of murrelets from other breeding islands (*e.g.*, Anacapa, Santa Cruz, Santa Catalina, and Coronado islands) feeding near SBI in these years (*e.g.*, Whitworth *et al.* 2000, Karnovsky *et al.* 2005, Hamilton *et al.* 2011); and 3) at-sea survey densities may have included large numbers of sub-adult murrelets which were not included in the other population estimates.

Annual variation in timing of breeding and inherent variability in congregation attendance each night requires that an adequate number of spotlight surveys be conducted each year to ensure that counts are conducted on nights of peak or near peak attendance. Four of the seven round-island survey counts in 2009 (range = 645-802 birds) and all March-April round-island survey counts in 2010 were higher than any conducted in 2001-02 (max. = 530 birds) or 2008 (max. = 493 birds). Inadequate numbers of surveys ($n = 2-3$ per year) were conducted prior to 2009 to best assess if population numbers had changed since 2001, but with more years of data, long-term trends may become evident.

Although only small numbers of round-island surveys were conducted in 2001-02, we did

complete many “standard” spotlight surveys (6-7 nights/year) on two parallel transects (inshore and offshore) in protected waters off the northeast section of SBI (Fig. 8; Whitworth *et al.* 2003b). In 2002, standard survey counts on three nights (count range = 313-391 birds) were higher than any of the round-island survey counts that year (maximum = 300 birds on 24 April), indicating that round-island surveys were conducted on nights of relatively low congregation attendance and were not representative of the total murrelet population.

The standard survey inshore transect followed the same waypoints as a segment of the round-island survey transect from Arch Point to Graveyard Canyon (Fig. 8). These shared waypoints allowed for rough comparisons of murrelet numbers along this section of the round-island transect in 2001-02 (when many standard surveys were performed) with 2009-10 (when only round-island surveys were conducted). We noted a strong correlation ($r = 0.95$, $p < 0.0001$, $n = 19$; Fig. 21) between murrelet counts on the standard inshore transect and around the rest of the island, indicating that the standard survey inshore counts were representative of murrelet numbers around the entire island each night.

As for round-island surveys, standard inshore counts were somewhat variable over the breeding season (Fig. 22). Overall mean counts were much higher in 2002 (213 ± 112 birds; range = 85-367; $n = 7$ nights) and 2010 (202 ± 108 birds; range = 23-377; $n = 5$ nights) than in 2001 (116 ± 100 birds; range = 18-274; $n = 6$ nights) and 2009 (116 ± 84 birds; range = 9-205), although small annual samples of surveys, nightly variation in at-sea congregation attendance and annual differences in the nesting phenology and sampling periods undoubtedly affected the overall results (Fig. 22).

Assuming that at least one or more surveys each year were conducted on a night of peak or near peak attendance, subsamples of the data which exclude nights with low attendance (*i.e.*, three highest counts or annual maximum) may provide a better estimate of the total murrelet population attending at-sea congregations at an island in any given year. However, no differences in rough comparisons were noted. Means of the three highest counts were still considerably higher in 2002 (325 ± 36 birds) and 2010 (259 ± 50 birds) compared to 2001 (196 ± 72 birds) and 2009 (196 ± 9 birds). Likewise, annual maximum counts were higher in 2002 and 2010 (367 and 317 birds, respectively) compared to 2001 and 2009 (274 and 205 birds, respectively).

With only four years of limited survey data, we could not determine possible trends in murrelet numbers attending at-sea congregations over the period 2001-10 (Fig. 23). More years of round-island and standard inshore surveys (ideally with a minimum of 7-10 survey nights/year) are needed to best assess population trends with simple regression analyses. We did not include survey data from 2008 due to the small number ($n = 2$) and late timing of surveys that year which clearly were not representative.

When possible, spotlight surveys should be conducted throughout the breeding season to ensure that some counts are conducted on nights of peak or near peak attendance (Fig. 22). Annual peak counts over the period 2001-10 occurred as early as 1 April (in 2009) and as late as 8 May (in 2002). Ideally, spotlight surveys would commence in mid-March and extend through late May, although surveys into June may be needed in late breeding years. We consider complete round-

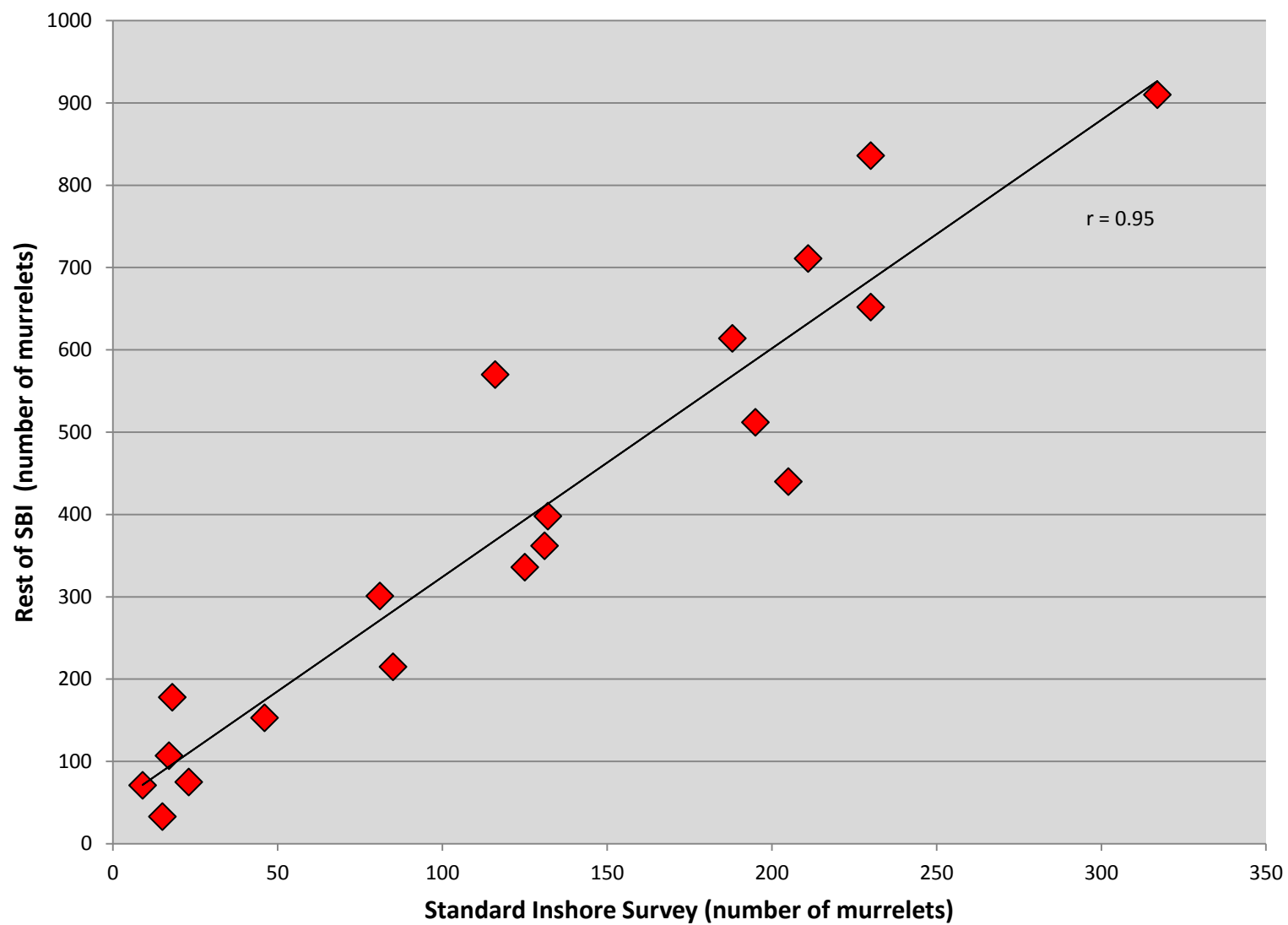


Figure 21. Relationship between numbers of Xantus's Murrelets observed on the standard inshore transect and around the rest of the island during round-island spotlight surveys at Santa Barbara Island in 2001-10.

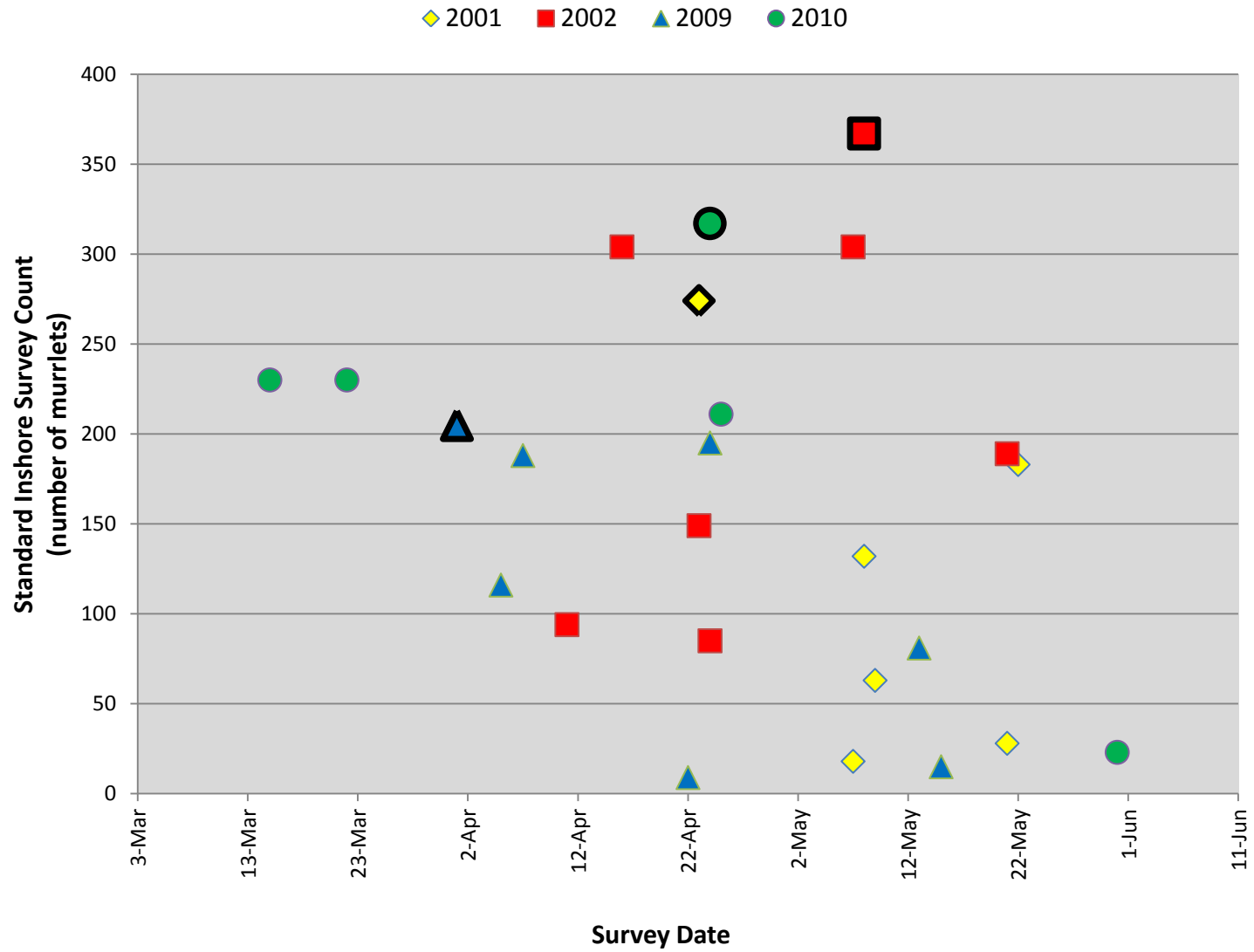


Figure 22. Numbers of Xantus's Murrelets observed on the standard inshore transect during spotlight surveys at Santa Barbara Island in 2001-10. Annual maximum counts are highlighted in bold.

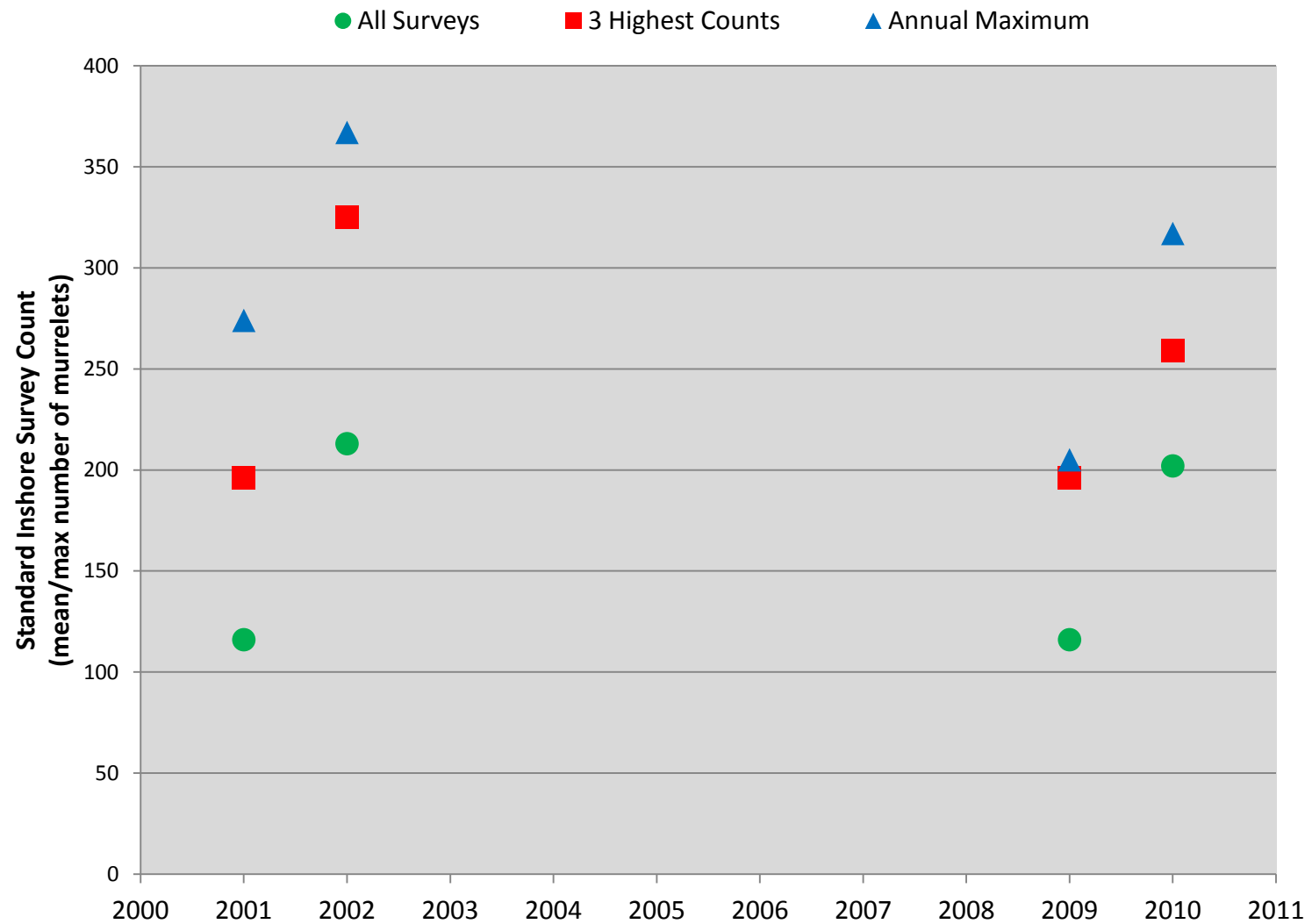


Figure 23. Standard inshore survey counts (mean of all surveys, mean of the three highest surveys, and the annual maximum survey) of Xantus's Murrelets observed during spotlight surveys at Santa Barbara Island in 2001-10.

island surveys preferable to partial surveys for best monitoring results because they account for any possible local shifts in murrelet distribution between different parts of the island. However, at SBI, the “standard” transect segment of the round-island survey (Fig. 8) was generally representative of numbers around the entire island (Fig. 21). This situation may reflect the location of the standard transect in more sheltered waters on the east side of the island which are regularly attended despite variable wind and weather conditions. Therefore, when persistent poor ocean conditions prevent conducting round-island surveys (as occurred in 2010), standard surveys provide a reasonable alternative whenever conditions permit surveys along the protected lee shore of the island.

NEST SEARCHES – Assuming our murrelet breeding population estimate (491-638 breeding pairs) for 2010 is accurate, nest searches and monitoring (including the CINP Cat Canyon plot) accounted for 26-34% (166 nests) of all murrelet nests on SBI that year. We suspect that the distribution of murrelets in at-sea congregations around the island broadly reflected breeding distribution (Appendix 1). Thus, large numbers (325-472 breeding pairs) apparently nested outside monitored plots in relatively inaccessible habitats at SBI, primarily on the cliffs and steep slopes on Signal Peak, North Peak and Sutil Island.

Extensive nest searches in 2009-10 served two of our primary goals: 1) locating accessible murrelet nest sites which could be included in future annual monitoring; and 2) permanently marking occupied sites in a variety of habitats around the island for determination of long-term population trends with non-annual nesting surveys. Long-term declines from the late 1980s through at least 2002 in the number of occupied murrelet nests within the Cat Canyon and Nature Trail long-term monitored plots may eventually result in an insufficient number of active nests that are not representative of the entire colony for examining reproductive success, breeding phenology or changes in population size. If long-term plots become inadequate in the near future, an adequate sample of nests ($n \geq 25$) can be found more widely around the island and monitored for many of the same purposes. In 2008 and especially 2009-10, we identified many active nests in the Arch Point North Cliff ($n = 28$), Landing Cove Boxthorn ($n = 25$) and West Cliff areas ($n = 26$) that were accessible by foot from the Ranger Station and were incorporated into the CINP monitoring program in 2010 (Table 3). Some of these sites had been discovered during earlier work in 1991-2004 (Carter *et al.* 1992; Whitworth *et al.* 1997b, 2003a, 2005a).

Nest surveys conducted every 3-5 years more widely around SBI would provide important additional data for confirming trends found in the CINP plots. Another value of measuring reproductive success in nests in various habitats around the island is that such a sample is more likely to be representative of the whole island because local factors affecting success on one part of the island will only affect a small part of the overall sample. Past monitoring has been subject to biases from localized effects of breeding habitats, predation, and disturbance in the relatively small and homogenous plots. For example, degradation of Silverlace (*Constancea nevini*) bushes in the Nature Trail plot has resulted in the loss of many monitored murrelet nest sites since the 1970s (Carter *et al.* 1992; Wolf *et al.* 2000; Burkett *et al.* 2003; Whitworth *et al.* 2003a). Nest searches were not conducted until 2001 to determine if murrelet nesting even occurred in adjacent areas (Whitworth *et al.* 2003a). Furthermore, the Nature Trail plot has not been monitored since 2005 due to recent nesting by Brown Pelicans (*Pelecanus occidentalis californicus*) in this area. This fact alone led to a reevaluation of the reliance upon a few long-

term plots as being representative of murrelet breeding at SBI, especially since (until recently) nearly all the CIMP monitored shrub sites were within this plot. In 2010 and subsequent years, continued nest searches augmented by more frequent monitoring in some of the readily accessible upper island habitats should provide better measures of breeding in different types of habitat.

Nest surveys conducted on the Arch Point North Cliffs in 1996, 2001 and 2009 provided additional evidence of possible population decline outside CIMP monitored plots. In 1996 and 2001, respectively, 22 and 20 active murrelet nests in rock crevices were found in this area (Whitworth *et al.* 1997b, 2003a), but only nine occupied sites were found there in 2009 (Fig. 2). However, nest searches and monitoring in 2010 documented higher numbers of active nests in most areas we surveyed. Many additional nests were noted in the upper island plots where monitoring by CIMP was more frequent, but it is unlikely that increased survey effort was the only factor affecting this change, as nest numbers also were markedly higher in the Arch Point Cove and Graveyard Canyon shoreline plots where less frequent searches were conducted. Little or no change was noted in sea caves and other shoreline plots, but a limited number of vacant breeding sites were available. Twenty-six nest sites identified in 2009 but not marked as active nests (because we could not reliably date the evidence of breeding) could have accounted for up to 40% of the increase in nest sites in 2010.

Minimum hatching success (assuming all clutches with unknown fates failed) at SBI was 54% in 2009 and 51% in 2010. However, our nest check schedule in 2009-10 was not designed to provide the detailed monitoring data required to obtain reliable estimates of hatching success, as evidenced by the large number of unknown clutch fates both in years ($n = 65$ or 26%; Table 3). Several biases and difficulties with data interpretation resulted from: 1) nest checks conducted 3-5 weeks apart; and 2) our inability to continue nest checks through completion of breeding activity at some sites. Incomplete monitoring data was collected for many sites in both 2009 ($n = 15$) and 2010 ($n = 22$) that were still active when the site was last visited. In some cases late active nests could not be checked because personnel were not available that late in the season, but in other cases landing in sea caves and shoreline areas was prevented by high swells, or potential disturbance to nesting seabirds or California Sea Lions with young pups. Thus, we chose not to calculate annual hatching success for the full data set.

We suspect that most clutches probably did not hatch in those nest sites where nesting was complete but no evidence of hatched, broken or abandoned eggs was found, because we could not objectively determine a clutch fate when considering all the possible alternatives over the long interval between nest checks. Even with shorter intervals between nests checks, determining Xantus's Murrelet clutch fates is often difficult compared to most other alcid species. Precocial murrelet chicks depart nest sites 2-3 nights after hatch and are raised to independence by adults at sea, while semi-precocial alcids (*e.g.*, Cassin's Auklet) are reared in the nest site for several weeks before fledging without further parental care. Hatching can be confirmed more easily through observing the chick with more widely spaced nest checks in semi-precocial alcids; this rarely occurs in murrelets.

At Anacapa Island in 2000-10, almost all successful clutches (99%; $n = 206$) left identifiable hatched eggshell fragments in the nest site that were found within 1-3 weeks of hatch

(Whitworth *et al.*, in prep.). Very few unknown clutch fates (3%; $n = 269$ total clutches) were documented where eggs went missing near or at the end of the incubation period. However, breeding conditions for murrelets at SBI, where mouse densities are very high compared to other islands, are different than Anacapa. Murrelet breeding habitats at Anacapa Island occur mainly in sea caves and cliffs which are separated from the upper island vegetated habitats where mouse densities are highest. In contrast, high mouse densities occur in monitored breeding habitats at SBI, resulting in higher depredation or scavenging of murrelet eggs and chicks, and more rapid removal of whole, broken or hatched eggshells than at other colonies.

A reliable estimate of hatching success was obtained in the upper island plots monitored by CINP in 2010. The relatively high overall hatching success (66% of clutches with known fates) combined with the large number of nest sites with sequential clutches ($n = 37$) indicated that 2010 was an exceptional year for murrelets breeding at SBI. The possible factors affecting murrelets breeding at SBI in 2009-10 will be discussed in later reports (Harvey *et al.*, in prep.; Karnovsky *et al.*, in prep.).

MURRELET EGG LOSS AND ADULT DEPREDATION – In contrast to the population declines observed at SBI since at least 1991 (Carter *et al.* 1992, Whitworth *et al.* 2003a, 2009a, Schwemm *et al.* 2005), nest monitoring data at Anacapa Island indicated strong population growth in monitored plots since 2004 (Whitworth *et al.* 2005b, 2009b, in prep.). This is a noteworthy difference considering the extensive overlap in foraging, chick-rearing and wintering areas between murrelets from these two colonies (Whitworth *et al.* 2000, Hamilton *et al.* 2011) and suggests that factors at the colony and not insufficient prey resources were primarily responsible for population declines at SBI. Much emphasis has been placed on poor hatching success due to egg predation by high densities of Deer Mice at SBI (Murray *et al.* 1983; Drost and Lewis 1995). Low hatching success has been documented in several years but there was no apparent correlation between springtime mouse densities and annual rates of egg depredation/scavenging from 1993-2002 (Schwemm and Martin 2005), although mouse densities were not determined near murrelet breeding areas and may not be representative.

The underlying causes of poor hatching success can rarely be confirmed with nest monitoring alone and often involves subjective interpretation. Failure to hatch is usually inferred when monitoring data documents: 1) “broken eggs”; 2) “missing eggs” (*i.e.*, disappearance of the clutch prior to the earliest possible hatch date); or 3) “abandoned” eggs (*i.e.*, whole eggs that are no longer incubated prior to potential hatch). It has been widely assumed that Deer Mice were responsible for most broken and missing eggs at SBI (although some eggs may be broken by adults competing for nest sites). Indeed, Deer Mice are the only known egg predator/scavenger on SBI and undoubtedly consume large numbers of murrelet eggs. However, it is highly unlikely that mice can take murrelet eggs from actively incubating adults (Blight *et al.* 1999, Drever *et al.* 2000). Our interpretation is that most egg loss is related to physiological, behavioral or environmental factors that result in unattended eggs before incubation begins, and short-term egg neglect or abandonment after incubation has commenced.

Much egg depredation by mice occurs prior to commencement of incubation on unattended first eggs during the 8-day period before the second egg is laid and during the first 2 days after laying of the second egg when eggs often are not incubated (Murray *et al.* 1983, Harvey and Barnes

2009). After incubation commences, many clutches are exposed to possible depredation by mice during periods of egg neglect when eggs can be left unattended for 1-3 days and remain viable (Murray *et al.* 1980, 1983). Many clutches are also exposed to depredation by mice when abandoned after incubation commences (Murray *et al.* 1983). The causes of egg neglect and clutch abandonment are difficult to determine, but could result from poor foraging conditions (*i.e.*, insufficient accessible prey within foraging distance of the colony), disturbance at the nest site, and adult predation (or avoidance of nesting duties due to the presence of predators).

Given the large number of owl depredated murrelet carcasses collected at SBI over many years, we suspect that the great potential effect of adult predation on hatching failure has been underexplored. Depredation by owls has probably played a significant but undetected role in many nest failures, leading to many cases of egg abandonment and then scavenging. In addition, attempted depredation by owls also may lead to some egg neglect and then egg predation. Clearly, more work is needed to examine dynamics of the predator-prey relationships among mice, owls and murrelets, specifically: 1) the relationship between murrelet egg loss and mouse density; and 2) the possible inverse relationship between owl depredation on mice and adult murrelets.

Barn Owls have long been considered the most significant avian predator of small seabirds at SBI (Murray *et al.* 1983, Drost 1989, Drost and McCluskey 1992, Drost and Lewis 1995). Owl numbers at SBI can be quite variable from year to year (Drost 1989, Drost and Lewis 1995), but over 30 owls were estimated at SBI in 1999 (Wolf *et al.* 2000). Owl depredation on murrelets also appears to be quite variable from year to year and inversely related to mouse abundance (Drost 1989, Drost and Lewis 1995). Murray *et al.* (1983) reported 109 carcasses from a roosting cave checked in 1976-78. Standardized carcass counts conducted on upper island paths from 1982-87 (Drost 1989) ranged from 16 carcasses (in 1982) to 130 carcasses (in 1983), while non-standardized surveys conducted in 1996-99 increased steadily each year from eight to 165 carcasses (Wolf *et al.* 2000). The peak carcass count in 1999 may have reflected an unusual influx of owls in response to bright lights from extensive squid-fishing boats (Wolf *et al.* 2000; P. Martin, pers. comm.). We could confirm only one pair of nesting owls on SBI in 2009 (a pair with four fledglings in Barn Owl Cave), but even the impact of this one pair was undeniable - at least 79 murrelet carcasses were found at this site alone (Fig. 15). Rough estimates of annual owl predation may approach 60-400 murrelets (3-8% of the total murrelet population of 2,000-5,000 birds including adults and subadults) in some heavy predation years. However, comprehensive carcass surveys at owl nests, roosts, and plucking stations have never been conducted and are not feasible. Total numbers of owl depredated murrelets killed annually may exceed rough estimates.

Since owls hunt exclusively on the island, they likely take a high proportion of adult murrelets, since adults may visit the island more frequently and spend more time on the island than do subadults. One murrelet carcass recovered in Barn Owl Cave in 2008 had been banded in May 1996, and was at least 13 years old when depredated. Four murrelet carcasses recovered at owl roosts in 1999 (Wolf *et al.* 2000) also had been banded in 1996-97, and were at least 3-4 years old when depredated. The loss of breeding adults has great long-term impacts on populations of long-lived species with low reproductive rates and is a greater concern than the loss of subadults or individual years with poor hatching success. The potential for cumulative negative effects of long-term owl depredation on murrelet population dynamics are obvious and merit further study.

To address these issues, projects began in 2010 to replicate owl censuses conducted in 1982-87 (Drost 1989) and 1996-99 (Wolf *et al.* 2000), and to examine owl diet and habitat use at SBI (Thomsen and Harvey 2011).

Peregrine Falcons (*Falco peregrinus*) are another significant avian predator of Xantus's Murrelets at SBI (Howell 1910, Murray *et al.* 1983, Drost and Lewis 1995). A falcon nest was confirmed on SBI in 2007, the first successful nest documented on SBI since they re-occupied the island in 1995 (B. Latta pers. comm.). The falcon aerie, located on the steep southern cliff below Signal Peak, was inspected on 19 April 2007 when three chicks were found and subsequently banded on 9 May (aged 21 days old; Santa Cruz Predatory Bird Research Group [SCPBRG] unpubl. data in Harvey and Barnes 2009). Murrelet feathers were found in the nest site, but their remains comprised only one of the 43 individual prey items analyzed from the feather pile and 13% of the calculated total prey biomass collected from the nest (Harvey and Barnes 2009). In comparison, murrelets represented 6.7% of the total biomass of combined prey remains collected from a comprehensive Peregrine Falcon survey of the Channel Islands in 2007 (SCPBRG unpubl. data). However, the overall number of murrelets consumed by falcons at SBI is likely underestimated by only examining prey remains from nest sites. Adults may consume large number of murrelets and eat them at other roost locations. Falcons were noted on several occasions at SBI in 2009-10, but their current breeding status on the island and potential impacts on the murrelet population are unclear.

AT-SEA CAPTURES – Mark-recapture studies should be incorporated into the long-term monitoring program to provide independent estimates of population size, survival and trends for comparison to nest monitoring and spotlight surveys. If assumptions can be satisfied to a reasonable degree, mark-recapture data may be less biased at indicating trends than other survey methods. However, adequate capture effort must be expended each year and over at least 3 adjacent years to ensure sufficient recaptures for reliable estimates. Some short-term recapture avoidance may occur, but data from 1995-97 capture studies showed that a considerable portion (13%) of all birds captured were recaptures by the third year of the study (Whitworth *et al.* 1997a,c).

When recaptured in 2009-10, five murrelets banded in 1995-96 (when they were at least one year old) were 14-16 years old. The oldest known murrelet was at least 16 years old when it was captured by hand at SBI in 1991 after being banded in 1977 when it was at least one year old (Carter *et al.* 1992). One murrelet banded and radio-marked in 1995 and recaptured in 2009, was not located during telemetry surveys in 1995 (Whitworth *et al.* 1995) and was not recaptured during subsequent at-sea capture efforts at SBI in 1996-97, 2001-02 or 2004 (D. Whitworth and H. Carter, unpubl. data). The other murrelets banded in 1995 were recaptured at SBI in 1996, but not again until 2009 or 2010. Two murrelets banded in 1996 were not recaptured until 2009.

Two *hypoleucus* murrelets off Webster Point on 16 May 2009 likely represented northward dispersing birds from Guadalupe or San Benito Island. This late season observation date matches the usually earlier timing of breeding in central Baja California with subsequent northward dispersal. This pair was seen well off the island and away from any other murrelets attending at-sea congregations. Sightings of *hypoleucus* murrelets near southern California breeding islands are extremely rare during the breeding season, except at San Clemente Island where regular occurrence during at-sea captures suggests that a small number may breed there (Carter *et al.*

2009). However, one record exists of a *hypoleucus* murrelet nesting in a site on SBI in 1977 and 1978 (Winnett *et al.* 1979). This *hypoleucus* murrelet was apparently paired with a murrelet of intermediate facial plumage (Jehl and Bond 1975) in 1978, but the mate of this bird was not seen in 1977.

FUTURE MURRELET RESEARCH AT SBI – To best determine k correction factors for use at SBI, 7-10 spotlight surveys at SBI should be conducted annually, in conjunction with weekly nest searches of all accessible upper island and shoreline areas from Arch Point to Nature Trail. Unfortunately, complete nest searches in this area are difficult to conduct annually because of difficult climbing (without safety ropes) on some upper-island habitats and difficult boat landings in some coastline areas. Annual spotlight surveys also would need to be included in long-term seabird monitoring efforts at SBI. In addition to the use of k correction factors at SBI, k values developed at SBI could be applied (with modifications as needed) to other colonies to derive breeding population estimates from spotlight surveys (Whitworth and Carter, in prep.). Northeast SBI is the only relatively large section of coastline at a breeding colony in the California portion of the range that has a large number of accessible nests (Whitworth *et al.* 2003a). Thus, k correction factors cannot be determined at other colonies with existing data collection methods.

To complement new Barn Owl studies which began in 2010, innovative studies are needed to examine survival/mortality of breeding Xantus's Murrelets without causing significant disturbance or nest abandonment. Breeding murrelets are quite sensitive to daily or frequent capture at nest sites and will readily abandon clutches, particularly if handled early in incubation (Murray *et al.* 1983; D. Whitworth, unpubl. data). Techniques that do not require frequent capture and recapture to identify nesting individuals are needed. However, murrelets appear to be much more tolerant when captured from nests late in the incubation period and while brooding chicks (D. Whitworth, unpubl. data).

A pilot study involving the implantation of a Passive Integrated Transponders (PIT) and traditional banding in a small sample ($n = 10$) of chick-brooding murrelets captured from closely monitored and easily accessible nests is sorely needed to examine the effects of a single capture and handling. We suspect that these marked adults would stay with their chicks until nest departure, experience little or no effects on chick-rearing at sea, and would return to breed in these sites in future years where their pit tag could be detected without handling. Once the effectiveness of this approach was demonstrated, we recommend that all adults in easily-accessible sites (*i.e.*, where adults can be captured and removed for tagging without injuring the adult or chicks) should be tagged and banded. Long-term monitoring of individual birds, including, annual survival/mortality, long-term site fidelity, and annual reproductive effort, would greatly enhance current monitoring efforts. For the pilot study, birds implanted would be taken from sites located outside of CINP monitored plots to avoid any concerns about possible effects on monitoring data. In addition, stationary PIT tag readers could be deployed at certain sites to obtain data on daily nesting behavior of tagged murrelets.

Estimates of adult survival can also be obtained indirectly through genetic analysis of eggs and eggshell fragments to determine parentage of clutches (V. Friesen, pers. comm.) from a particular site over many breeding seasons, as well as sequential clutches laid in a site within a breeding season. Another value of determining parentage of collected eggshells from nest sites

would be identifying whether sequential clutches in the same site are laid by the same or different pairs. This knowledge would improve our estimates of hatching success per breeding pair and number of breeding pairs being monitored each year. Egg and eggshell collections for genetic studies can be easily incorporated into the current SBI monitoring programs with no added expense.

Ashy Storm-Petrel

Nest searches and spotlight surveys confirmed the presence and nesting of Ashy Storm-Petrels at SBI in 2009-10. Although first noted at SBI in 1904, breeding was not confirmed until nest discoveries at Sutil Island (one or more nests) and SBI proper (one nest; location not known) in 1976-77; however, 58 birds were mist-netted and 300 breeding birds were estimated (Hunt *et al.* 1979). In 1991, one nest also was found on SBI proper between Arch Point and Pinnacle Point but 393 birds were mist-netted, most with brood patches, indicating a larger population estimated at about 1,460 breeding birds (Carter *et al.* 1992). Nest searches in sea caves in May 2008 resulted in several nest discoveries at Elephant Seal Point (Whitworth *et al.* 2009a). As in 2008, small numbers of active nests and potential nest sites found in 2009-10 were discovered in sea caves and on the north shore cliffs indicating that storm-petrels breed in largely inaccessible habitats at SBI. Reproductive success for the colony could not be estimated from this small and possibly biased sample of nests, although none of the three active nests in Elephant Seal Point Cave A were successful. Reproductive success in Elephant Seal Point Cave A likely did not reflect conditions around the entire island, as breeding in the cave was affected by the presence of at least one Barn Owl which likely extirpated most, if not all small crevice nesting seabirds that attempted to breed there in 2009-10. A larger sample of storm-petrel nests for standardized monitoring of reproductive success and breeding phenology could be found at SBI but would require greater search efforts in shoreline and sea cave habitats that extend beyond the March-June period of the current seabird monitoring program in these habitats. Ashy Storm-Petrels laid eggs between May and August 2009-10 at nearby Santa Cruz Island (McIver *et al.* 2010, 2011).

Given the difficulty in finding and monitoring storm-petrel nests at SBI, we recommend that: a) mark-recapture analyses of mist-net captures of birds throughout the breeding season for periodic estimation of population size, comparable to other species (Carter *et al.* 1992); and b) analyses of changes in capture rates throughout the breeding season over several years for measuring trends in population size over time. CINP initiated new efforts in 2009 to monitor storm-petrel populations at SBI and results will be presented separately (L. Harvey, unpubl. data).

The unusually large number of storm-petrels (several hundred) observed during the 22 April 2009 spotlight survey suggested that the breeding population was substantial and possibly greater than the approximately 2,000 breeding birds estimated for all three breeding species (*i.e.*, including about 500 Leach's and Black Storm-Petrels [*O. leucorhoa* and *O. melania*]) in 1991 (Carter *et al.* 1992). However, only small numbers of storm-petrels (2-25 birds) were observed during spotlight surveys on other nights. In most cases, spotlight surveys are unsuitable for reliably quantifying presence, abundance or population changes of storm-petrels. We were not able to identify most individual storm-petrels to species during spotlight surveys to determine the relative proportions of the three breeding species, but those seen well were Ashy Storm-Petrels (Carter *et al.* 1992).

Rhinoceros Auklet

Breeding by Rhinoceros Auklets was suspected at SBI by Heermann in the late 1800's, but none were actually seen there (Baird *et al.* 1884). Howell (1917) doubted any breeding at SBI, and no confirmed nests have ever been found at the island, although small numbers were seen near the island during the breeding season in the 1980s and 1990s (Hunt *et al.* 1979, Carter *et al.* 1992, McChesney *et al.* 1995). In May 2008, small numbers (2-5 individuals or 1-2 pairs) were seen at night on the water adjacent to potential nesting areas during spotlight surveys, but none were seen at night at SBI during spotlight surveys in 2009 or 2010. However, a sub-adult was seen during the daytime on 5 April 2009 just off Arch Point in the same general area where an adult was found in May 2008 (Whitworth *et al.* 2009a). Considerable numbers were seen within 17 km of SBI during daytime radial surveys in 2009-10 (N. Karnovsky, unpubl. data). Although small numbers of Rhinoceros Auklets occasionally breed at San Miguel Island in the SCB (Carter *et al.* 1992, 2008, McChesney *et al.* 1995), most birds observed at sea away from colonies probably represented non-breeding adults and sub-adults that did not return or returned later to breeding colonies north of the SCB after wintering near SBI (Briggs *et al.* 1987, Mason *et al.* 2007).

Pigeon Guillemot

Small numbers of Pigeon Guillemots have been regularly documented breeding at SBI, the southern extent of their breeding range since being first observed there by Cooper in the 1860s (Baird *et al.* 1884). As for storm-petrels, observations of Pigeon Guillemots nesting in sea caves in 2008-10 confirmed breeding at SBI proper where 276 breeding birds were estimated in 1991, based on diurnal counts of birds that congregate at dawn on the shoreline and inshore waters near breeding areas (Carter *et al.* 1992). The small sample of nests found in 2008-10 was not adequate for assessing reproductive success or population trends. Guillemots are very rarely seen during nocturnal spotlight surveys at other colonies (D.L. Whitworth, unpubl. data), although we did see a group of three near Webster Point in May 2009. Early morning guillemot counts were conducted in 2009-10 and results will be presented separately (H. Carter and L. Harvey, unpubl. data).

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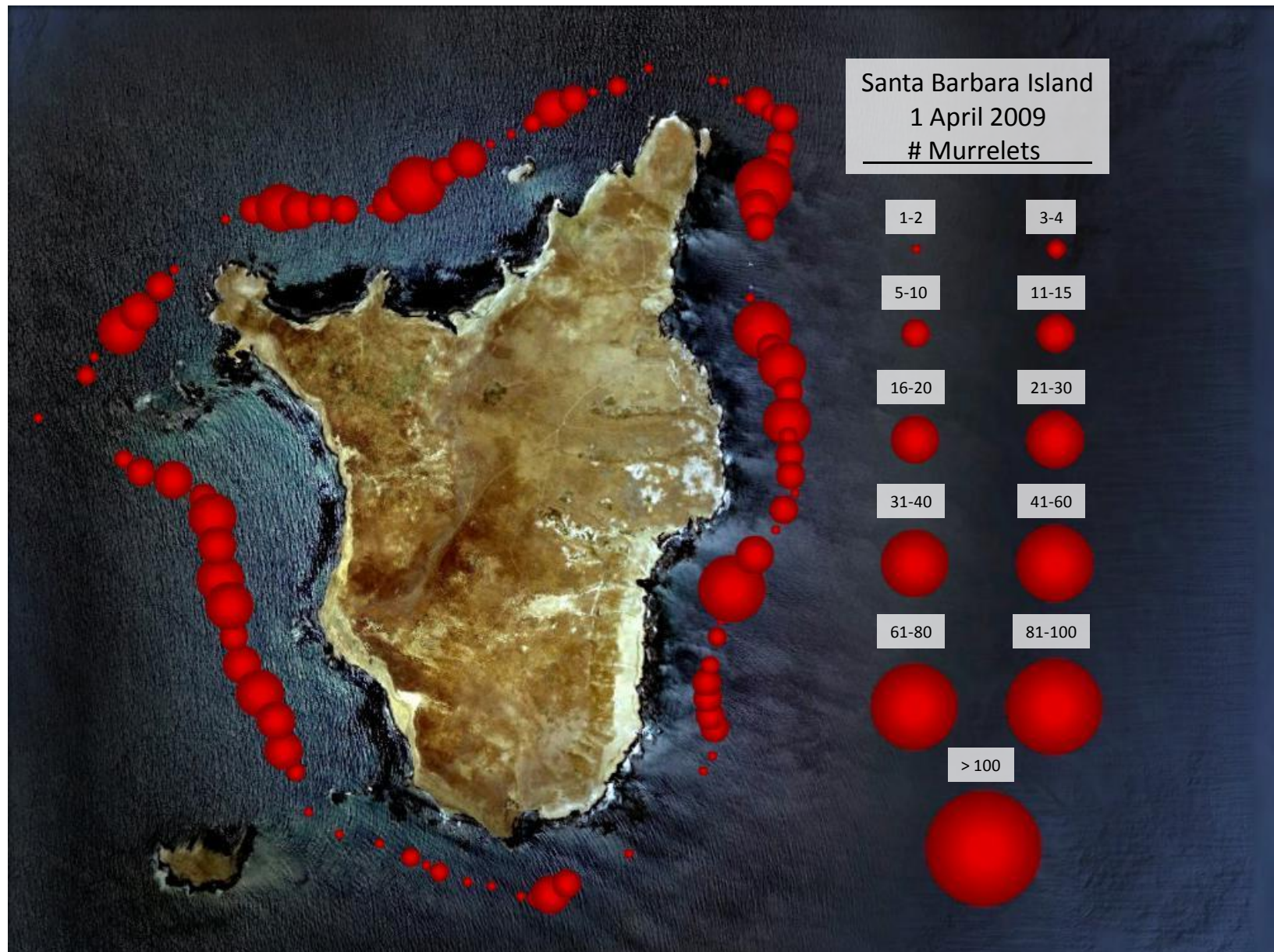
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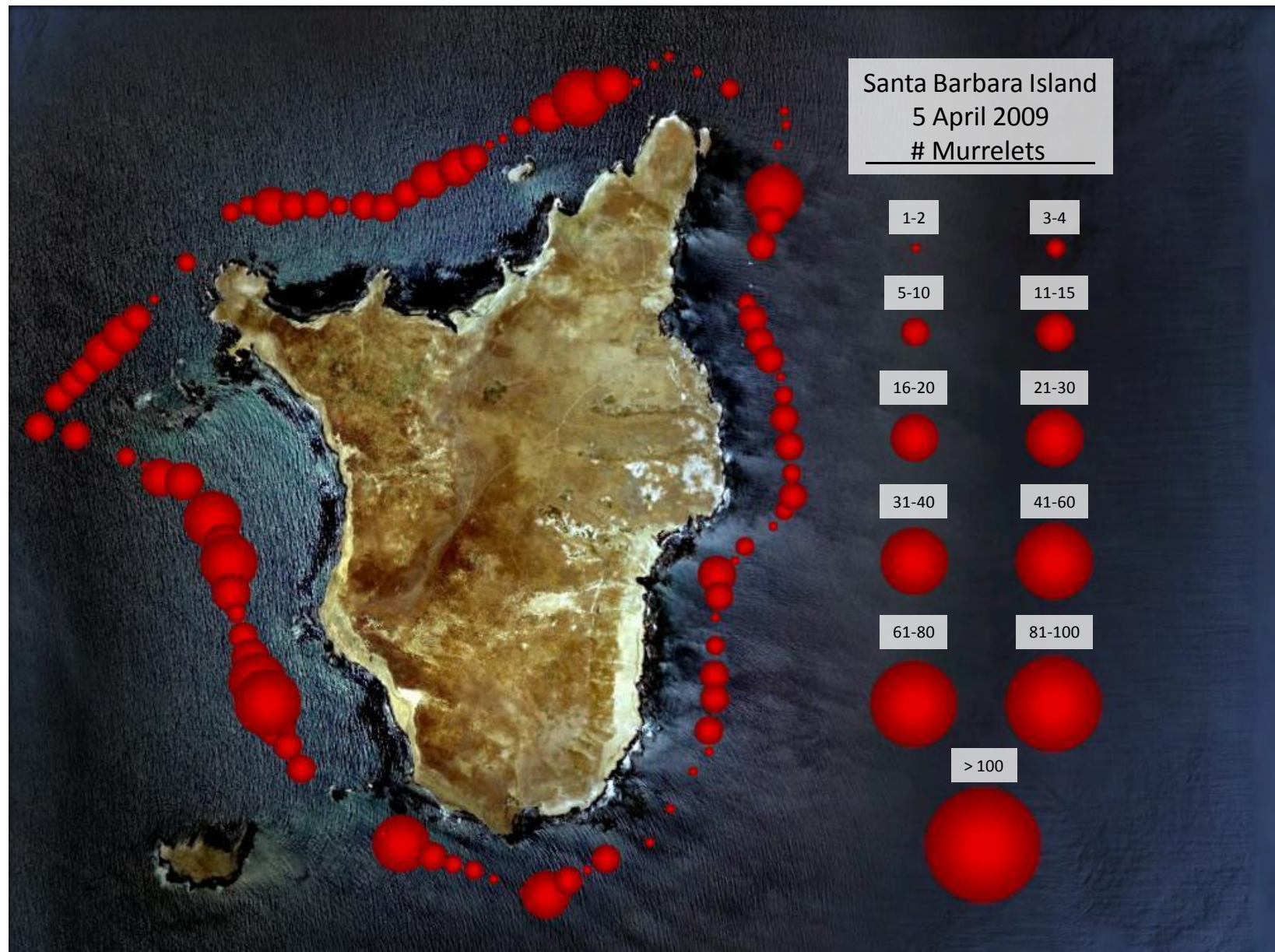
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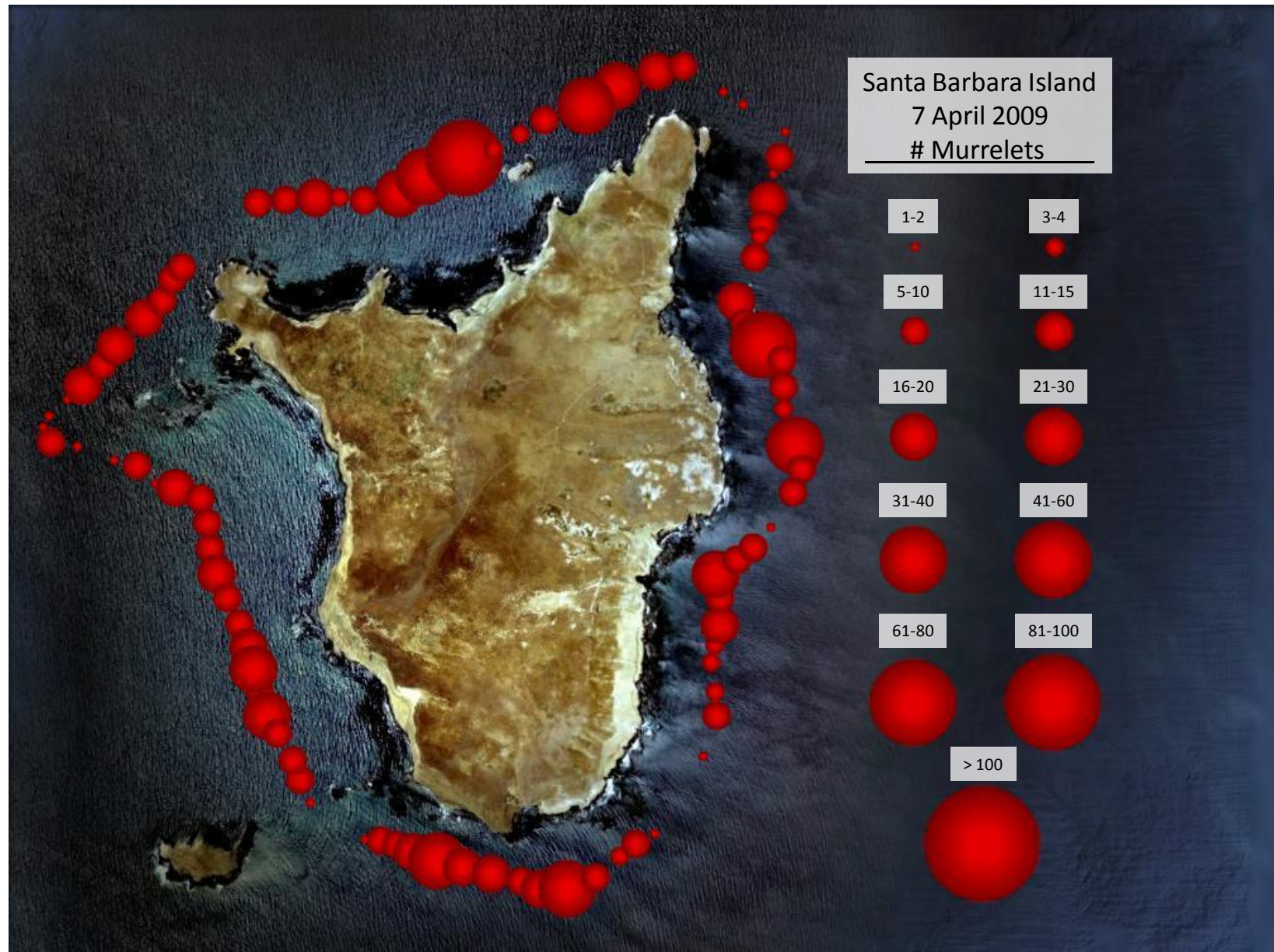
Appendix 1: Distribution of Xantus's Murrelets during nocturnal round-island spotlight surveys at Santa Barbara Island in 2009-10.



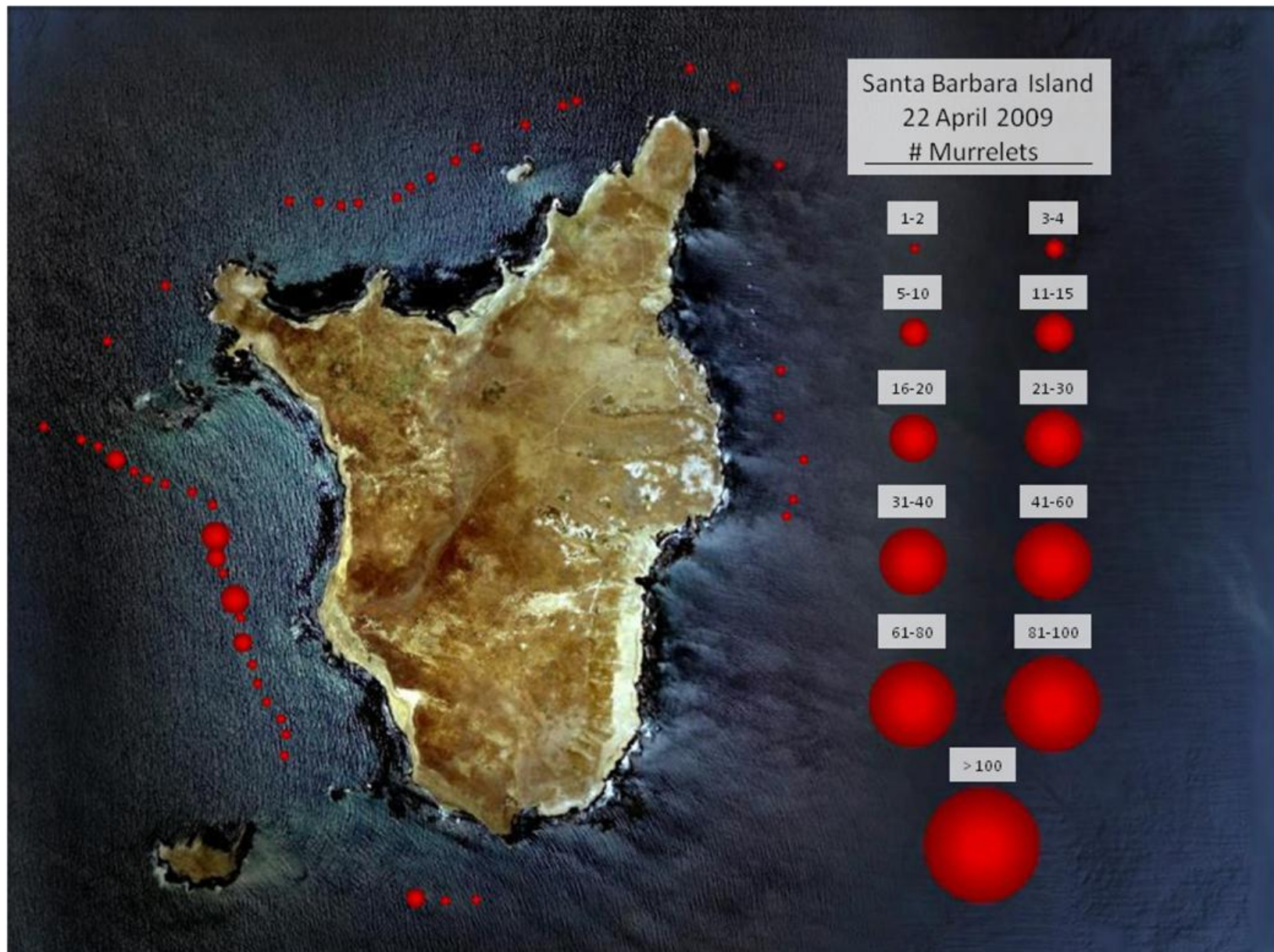
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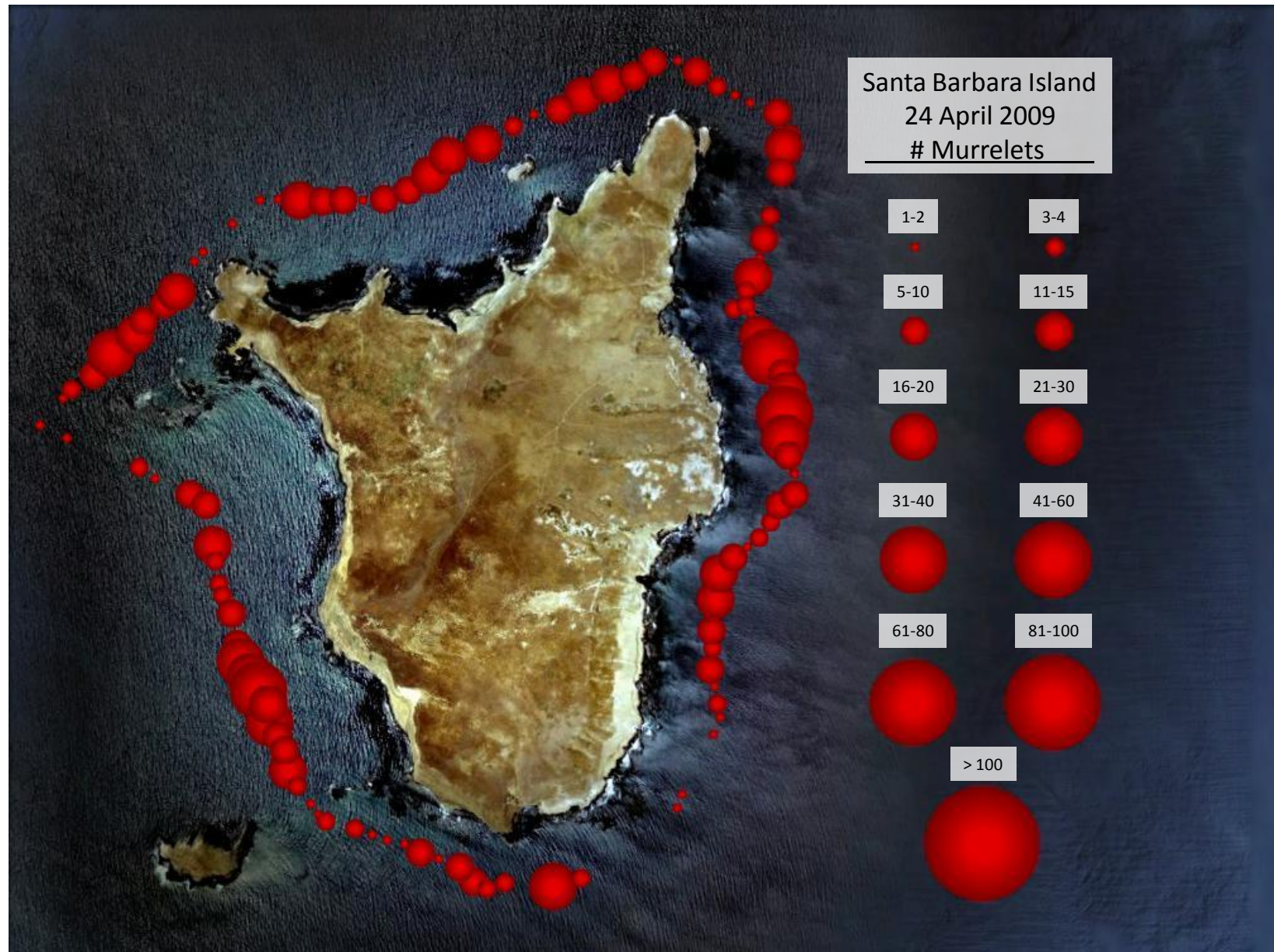
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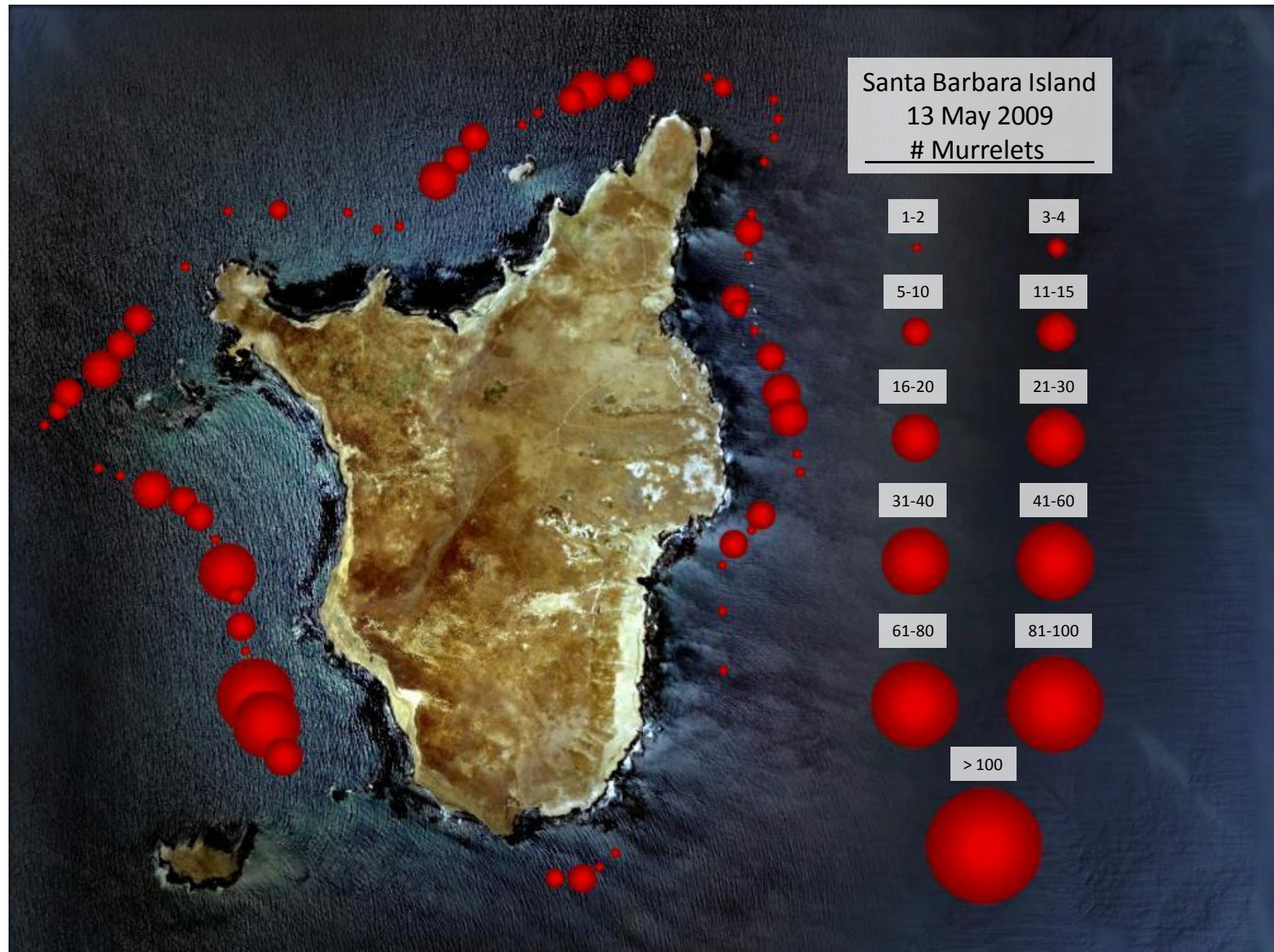
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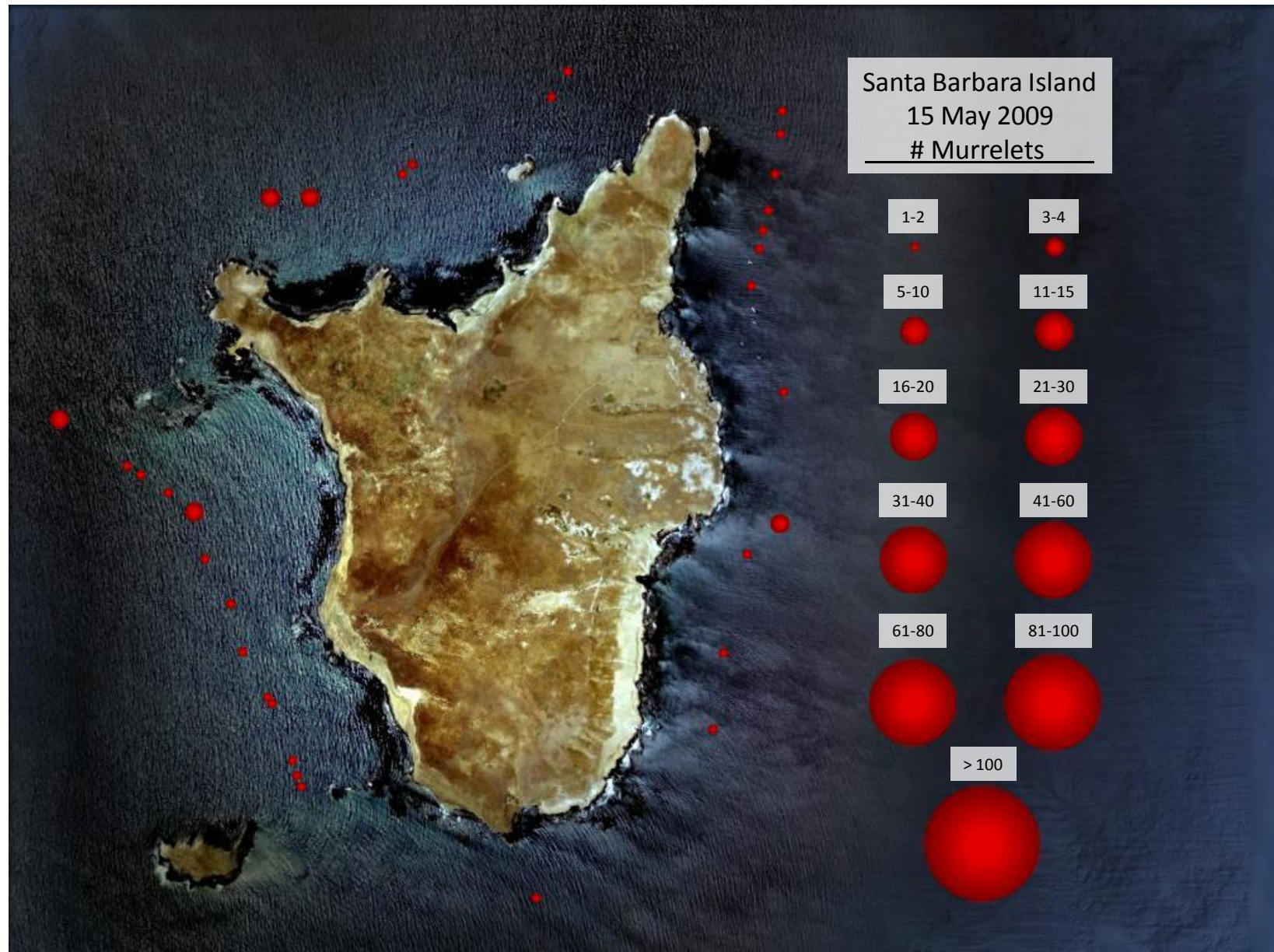
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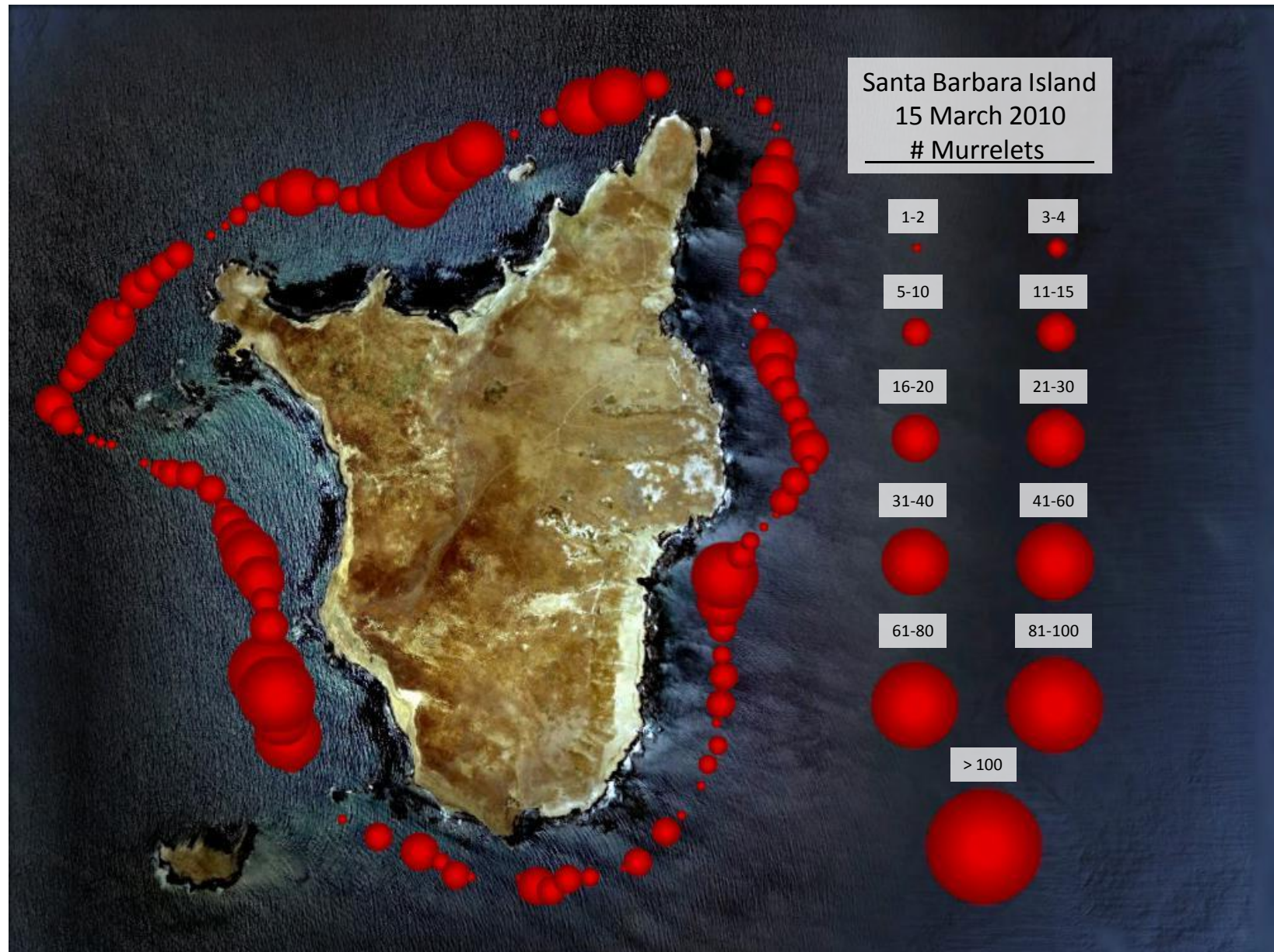
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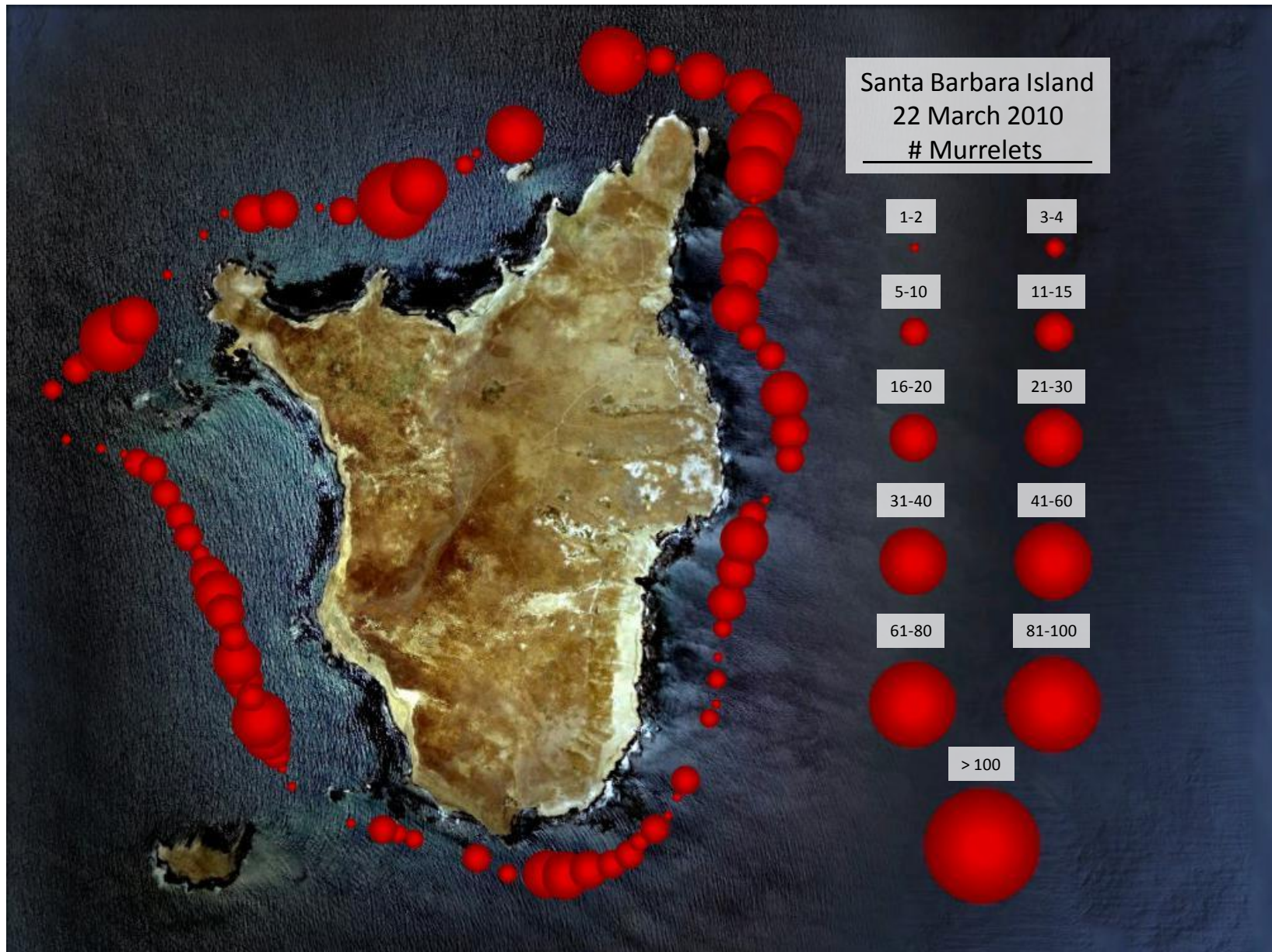
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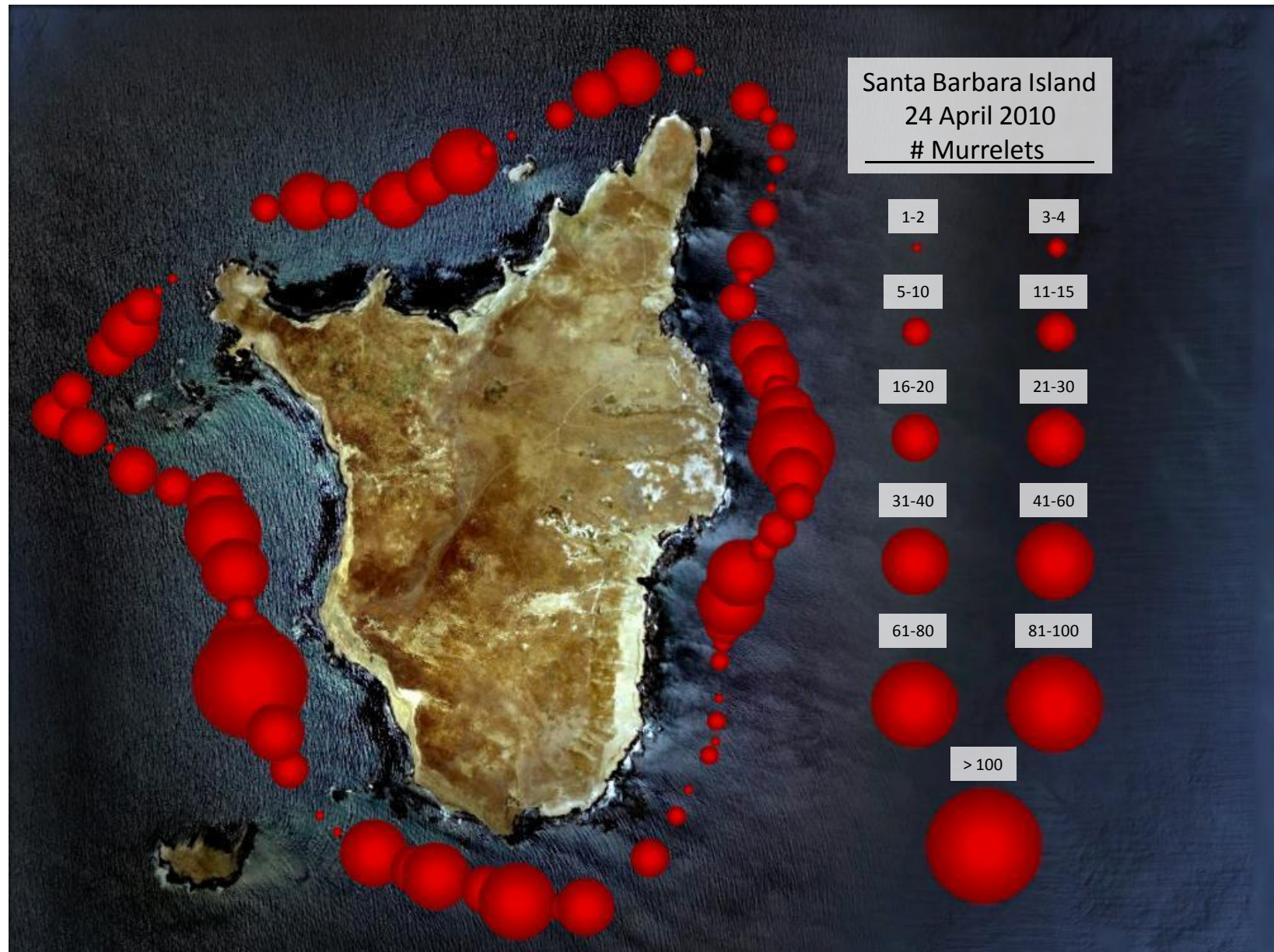
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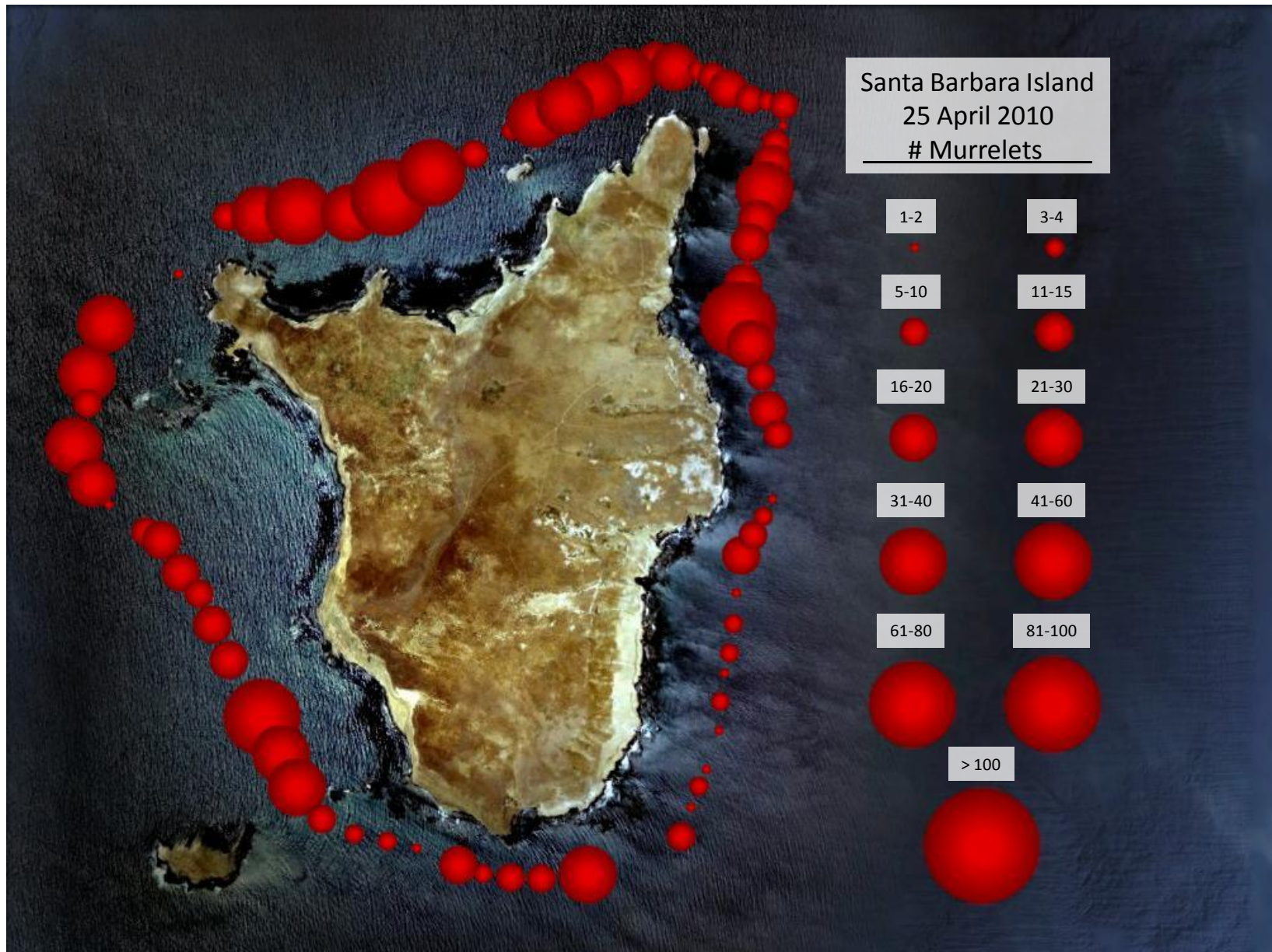
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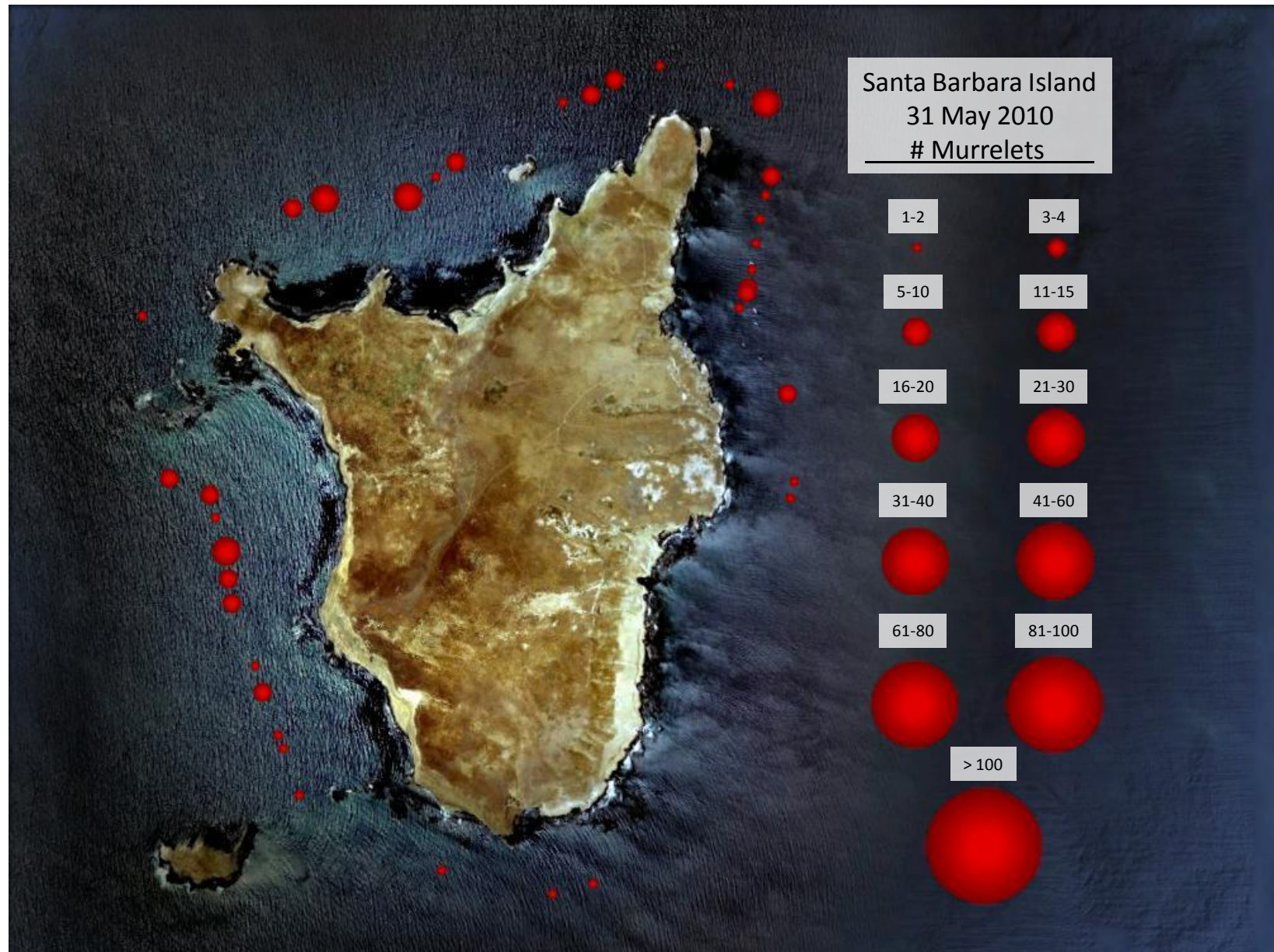
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Appendix 1: Distribution of Xantus's Murrelets during nocturnal round-island spotlight surveys at Santa Barbara Island in 2009-10.



Appendix 2: Banding data for Cassin's Auklets and Xantus's Murrelets captured (or recaptured) at Santa Barbara Island, California in 2009-10.

	Band	Species	Date	Location	Band/Recap	Capture Type
1313	35316	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	35317	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	35318	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	35319	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	35320	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	35321	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	35322	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	35323	CAAU	23-Apr-09	Sutil	New	Mist-net
1313	46101	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46102	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46103	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46104	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46105	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46106	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46107	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46108	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46109	CAAU	23-Apr-09	E Seal Pt	New	Mist-net
1313	46101	CAAU	14-May-09	E Seal Pt	Recap	Mist-net
1313	46102	CAAU	14-May-09	E Seal Pt	Recap	Mist-net
1313	46103	CAAU	14-May-09	E Seal Pt	Recap	Mist-net
1313	46104	CAAU	14-May-09	E Seal Pt	Recap	Mist-net
1313	46108	CAAU	14-May-09	E Seal Pt	Recap	Mist-net
1313	46110	CAAU	14-May-09	E Seal Pt	New	Mist-net
1313	46111	CAAU	14-May-09	E Seal Pt	New	Mist-net
1313	46112	CAAU	14-May-09	E Seal Pt	New	Mist-net
1313	46113	CAAU	16-May-09	N SBI	New	At-sea
1313	46114	CAAU	16-May-09	N SBI	New	At-sea
1313	46115	CAAU	16-May-09	Landing Cove	New	At-sea
1313	46116	CAAU	18-May-09	Landing Cove	New	At-sea
1313	46117	CAAU	19-May-09	Landing Cove	New	At-sea
1313	35324	CAAU	24-Jun-09	E Seal Pt	New	Mist-net
1313	35325	CAAU	24-Jun-09	E Seal Pt	New	Mist-net
1313	46103	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	46104	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	46105	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	46106	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	46108	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	46109	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	46111	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	46112	CAAU	24-Jun-09	E Seal Pt	Recap	Mist-net
1313	35326	CAAU	5-Mar-10	E Seal Pt	New	Mist-net
1313	35327	CAAU	5-Mar-10	E Seal Pt	New	Mist-net
1313	35325	CAAU	5-Mar-10	E Seal Pt	Recap	Mist-net

Appendix 2: Banding data for Cassin's Auklets and Xantus's Murrelets captured (or recaptured) at Santa Barbara Island, California in 2009-10.

	Band	Species	Date	Location	Band/Recap	Capture Type
1313	46102	CAAU	5-Mar-10	E Seal Pt	Recap	Mist-net
1313	46103	CAAU	5-Mar-10	E Seal Pt	Recap	Mist-net
1313	46104	CAAU	5-Mar-10	E Seal Pt	Recap	Mist-net
1313	46105	CAAU	5-Mar-10	E Seal Pt	Recap	Mist-net
1313	46108	CAAU	5-Mar-10	E Seal Pt	Recap	Mist-net
1313	46110	CAAU	5-Mar-10	E Seal Pt	Recap	Mist-net
1262	03001	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03002	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03003	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03004	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03006	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03007	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03008	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03009	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03010	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03011	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03012	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03013	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03014	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03015	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03016	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03017	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03018	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03019	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03020	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03021	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03022	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03023	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03024	XAMU	25-Apr-09	Landing Cove	New	At-sea
1262	03025	XAMU	25-Apr-09	Landing Cove	New	At-sea
892	98370	XAMU	25-Apr-09	Landing Cove	Recap	At-sea
1262	03015	XAMU	26-Apr-09	Landing Cove	Recap	At-sea
1262	03026	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03027	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03028	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03029	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03030	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03031	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03032	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03033	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03034	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03035	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03036	XAMU	26-Apr-09	Landing Cove	New	At-sea

Appendix 2: Banding data for Cassin's Auklets and Xantus's Murrelets captured (or recaptured) at Santa Barbara Island, California in 2009-10.

	Band	Species	Date	Location	Band/Recap	Capture Type
1262	03037	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03038	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03039	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03040	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03041	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03042	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03043	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03044	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03045	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03046	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03047	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03048	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03049	XAMU	26-Apr-09	Landing Cove	New	At-sea
1262	03050	XAMU	26-Apr-09	Landing Cove	New	At-sea
892	98195	XAMU	26-Apr-09	Landing Cove	Recap	At-sea
1262	03070	XAMU	14-May-09	E Seal Pt	New	Mist-net
1262	03071	XAMU	16-May-09	Webster Pt	New	At-sea
1262	03072	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03073	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03074	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03075	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03076	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03077	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03078	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03079	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03080	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03081	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03082	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03083	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03084	XAMU	18-May-09	Landing Cove	New	At-sea
1262	03085	XAMU	18-May-09	Landing Cove	New	At-sea
892	29855	XAMU	18-May-09	Landing Cove	Recap	At-sea
1262	03086	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03087	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03088	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03089	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03090	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03091	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03092	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03093	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03094	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03095	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03096	XAMU	19-May-09	Landing Cove	New	At-sea

Appendix 2: Banding data for Cassin's Auklets and Xantus's Murrelets captured (or recaptured) at Santa Barbara Island, California in 2009-10.

	Band	Species	Date	Location	Band/Recap	Capture Type
1262	03097	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03098	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03100	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03201	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03202	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03203	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03204	XAMU	19-May-09	Landing Cove	New	At-sea
1262	03205	XAMU	19-May-09	Landing Cove	New	At-sea
892	29869	XAMU	19-May-09	Landing Cove	Recap	At-sea
1262	03097	XAMU	20-May-09	Landing Cove	Recap	At-sea
1262	03206	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03207	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03208	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03209	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03210	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03211	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03212	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03213	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03214	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03215	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03216	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03217	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03218	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03219	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03220	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03221	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03222	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03223	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03224	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03225	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03226	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03227	XAMU	20-May-09	Landing Cove	New	At-sea
1262	03249	XAMU	25-Jun-09	Landing Cove	New	At-sea
1262	03101	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03102	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03103	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03104	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03105	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03106	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03107	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03108	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03109	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03110	XAMU	15-Mar-10	Landing Cove	New	At-sea

Appendix 2: Banding data for Cassin's Auklets and Xantus's Murrelets captured (or recaptured) at Santa Barbara Island, California in 2009-10.

	Band	Species	Date	Location	Band/Recap	Capture Type
1262	03111	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03112	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03113	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03114	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03210	XAMU	15-Mar-10	Landing Cove	Recap	At-sea
1262	03115	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03116	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03117	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03118	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03119	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03120	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03121	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03122	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03123	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03124	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03125	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03126	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03127	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03128	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03129	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03130	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03131	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03132	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03133	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03134	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03135	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03136	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03137	XAMU	15-Mar-10	Landing Cove	New	At-sea
1262	03138	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03139	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03140	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03141	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03142	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03143	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03144	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03145	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03146	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03147	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03148	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03149	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03150	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03151	XAMU	16-Mar-10	Landing Cove	New	At-sea
1262	03152	XAMU	16-Mar-10	Landing Cove	New	At-sea

Appendix 2: Banding data for Cassin's Auklets and Xantus's Murrelets captured (or recaptured) at Santa Barbara Island, California in 2009-10.

	Band	Species	Date	Location	Band/Recap	Capture Type
1262	03153	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03154	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03155	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03156	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03157	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03158	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03159	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03160	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03161	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03162	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03163	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03164	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03165	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03166	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03167	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03168	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03169	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03170	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03171	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03172	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03032	XAMU	3-May-10	Landing Cove	Recap	At-sea
1262	03173	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03174	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03175	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03176	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03177	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03214	XAMU	3-May-10	Landing Cove	Recap	At-sea
1262	03178	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03179	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03180	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03181	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03182	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03183	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03184	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03185	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03186	XAMU	3-May-10	Landing Cove	New	At-sea
1262	03187	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03188	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03189	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03190	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03093	XAMU	5-May-10	Landing Cove	Recap	At-sea
1262	03191	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03192	XAMU	5-May-10	Landing Cove	New	At-sea

Appendix 2: Banding data for Cassin's Auklets and Xantus's Murrelets captured (or recaptured) at Santa Barbara Island, California in 2009-10.

	Band	Species	Date	Location	Band/Recap	Capture Type
892	98104	XAMU	5-May-10	Landing Cove	Recap	At-sea
1262	03193	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03194	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03195	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03196	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03197	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03198	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03199	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03200	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03250	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03251	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03252	XAMU	5-May-10	Landing Cove	New	At-sea
1262	03253	XAMU	30-May-10	Landing Cove	New	At-sea
1262	03254	XAMU	30-May-10	Landing Cove	New	At-sea
1262	03255	XAMU	30-May-10	Landing Cove	New	At-sea
1262	03256	XAMU	30-May-10	Landing Cove	New	At-sea
1262	03257	XAMU	30-May-10	Landing Cove	New	At-sea
1262	03258	XAMU	30-May-10	Landing Cove	New	At-sea
1262	03259	XAMU	30-May-10	Landing Cove	New	At-sea
1262	03260	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03261	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03262	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03263	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03264	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03265	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03266	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03267	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03268	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03269	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03270	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03271	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03272	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03273	XAMU	1-Jun-10	Landing Cove	New	At-sea
1262	03177	XAMU	1-Jun-10	Landing Cove	Recap	At-sea
1262	03274	XAMU	1-Jun-10	Landing Cove	New	At-sea

Appendix 3: Location coordinates (degrees°, minutes' and seconds'') for round-island spotlight survey waypoints at Santa Barbara Island, California.

Waypoint	Latitude - Longitude
SB200A	N33° 29' 20.5'' - W119° 01' 30.3''
SB200B	N33° 28' 57.2'' - W119° 01' 36.9''
SB200C	N33° 28' 49.3'' - W119° 01' 31.2''
SB200D	N33° 28' 35.8'' - W119° 01' 29.0''
SB200E	N33° 28' 25.7'' - W119° 01' 39.7''
SB200F	N33° 28' 05.2'' - W119° 01' 40.9''
SB200G	N33° 27' 54.1'' - W119° 01' 48.2''
SB200H	N33° 27' 47.0'' - W119° 02' 04.7''
SB200J	N33° 27' 57.0'' - W119° 02' 37.4''
SB200K	N33° 28' 18.3'' - W119° 02' 48.0''
SB200L	N33° 28' 34.2'' - W119° 02' 52.2''
SB200M	N33° 28' 43.4'' - W119° 03' 16.9''
SB200N	N33° 29' 09.1'' - W119° 02' 48.6''
SB200O	N33° 29' 09.2'' - W119° 02' 27.3''
SB200P	N33° 29' 18.8'' - W119° 02' 08.3''
SB200Q	N33° 29' 27.2'' - W119° 01' 47.1''

Appendix 4.

Cassin's Auklets at Santa Barbara Island in 1991, with comparisons to 1976-77 and 2008-09

Harry R. Carter

I compiled field observations of Cassin's Auklets at Santa Barbara Island (SBI) in 1991 (Carter *et al.* 1992; unpubl. field notes) for comparison to field observations in 2008-09 (summarized earlier in this report) and 1976-77 (Hunt *et al.* 1979). Observations at SBI in 1991 were made during seabird colony surveys of all breeding seabird species conducted by Humboldt State University and U.S. Fish and Wildlife Service but many details were not provided in the final report. Details were compiled from the report, colony status records, and unpublished field notes. I then compared information on auklet breeding in 1976-77, 1991, and 2008-09.

1991 Field Observations at Elephant Seal Point

11-12 April 1991: Mist-net captures with storm-petrel vocalizations were conducted, using a 7-foot (2.1 m) high and 30-foot (9.1 m) long net placed in front of large fissure (21:18-01:57; H.R. Carter, L. Accurso) – one new auklet (#35870) with brood patches was captured at 21:40 without regurgitating prey as it flew in from the ocean. Another single auklet was observed departing from the fissure at 23:29 but no other auklets were seen with a flashlight in the fissure. No auklet vocalizing was noted during mist-net captures but auklets were noted vocalizing from below the net site (either in the sea cave area lower on the point or on the water beside the point) between 02:15 and 04:30.

12 April 1991: Mist-net captures without storm-petrel vocalizations were conducted in front of large fissure (04:45-06:10; H.R. Carter, L. Accurso) - two new auklets (#35871, #35872) with brood patches were captured at 04:53 and 05:13 as they departed from the fissure; neither regurgitated prey. Auklets were heard vocalizing from below the net site at 05:03. At 05:21, an auklet was heard calling from within the fissure. At 05:36, two auklets were heard vocalizing from the water below the nest site.

14 April 1991: Mist-net captures without storm-petrel vocalizations were conducted in front of large fissure (20:29-23:30; H.R. Carter, L. Accurso) – eight auklets (#35873, #35874, #35875, #35876, #35877, #35878, #35879, #35880) with brood patches were captured and banded that flew in from the ocean at 20:45, 20:53 (n = 2), 20:55, 21:00 (n = 2), 21:55 and 23:15; none regurgitated prey. One 11-12 April bird (#35871) also was recaptured at 21:28. At 20:37 and 21:07, single auklets hit the net and escaped. No auklet vocalizing occurred.

19 May 1991: Mist-net captures with storm-petrel vocalizations were conducted in front of large fissure (20:45-22:49; C.S. Strong, M. Cassaza) – four new auklets (#37001, #37002, #37003, #37004) with brood patches were captured and banded that flew in from the ocean at 20:51,

Appendix 4: Field observations of Cassin's Auklets at Elephant Seal Point and Sutil Island in 1991.

21:09, 21:25, and 21:49; three regurgitated prey. Four April auklets (#35872, #35874, #35878, #35879) were recaptured at 21:23, 21:25, 21:37, and 22:12; four regurgitated prey. Auklet vocalizing was not noted.

20 May 1991: Mist-net captures with storm-petrel vocalizations were conducted in front of large fissure (04:18-05:04; C.S. Strong, M. Cassaza) – two new auklets (#37005, #35006) with brood patches (including one April recapture) were captured and banded that departed from the fissure at 04:27 and 04:44; neither regurgitated prey. On April auklet (#35873) was recaptured at 04:22 without regurgitating. In addition, two auklets captured on the previous evening were recaptured. One auklet bounced out of the net and several other auklets flew by the net without being captured. Notes about auklet vocalizing were not taken.

1991 Field Observations at Sutil Island

13 April 1991: Diurnal nest searches were conducted on accessible parts of the island (16:45-19:00; H.R. Carter, G.J. McChesney, C. Drost) – in area A (“East Spire”), two auklet nests were found, one with an adult seen and one with an adult and egg seen; in area 8 (“North Central”), six nests were found, with adults seen only, and many other crevices were empty.

13-14 April 1991: Mist-net captures with storm-petrel vocalizations (using a 7-foot (2.1 m) high and 30-foot (9.1 m) long net) and nocturnal nest searches were conducted at top of the island (20:05-04:30; H.R. Carter, G.J. McChesney, C. Drost) – eight new auklets (#35901, #35902, #35903, #35904, #35905, #35906, #35907, #35908; five with brood patches and three without brood patches) were captured and banded at 22:00, 23:01, 23:10, 00:41, 01:45, 02:15, 02:29, 02:55, and 03:38; none regurgitated prey. At 21:37, several auklets were noted flying around and on the ground. At 23:00, auklets were noted attending entrances of six crevice/burrows (*i.e.*, all available sites) in the area of the net site and one dead adult was found. No eggs were seen. Many large and small holes were seen in the soil area on top and several deep holes appeared to be occupied burrows. At 02:15, auklets were heard occasionally. At 03:05, auklets were still calling occasionally.

4 June 1991: Diurnal nest searches were conducted on accessible parts of the island (19:25-20:30; H.R. Carter, G.J. McChesney, D.L. Whitworth) – during a nest count for Western Gulls, one nest found with adult seen, in one of the same sites occupied in April. Many crevices and burrows were investigated without finding evidence of eggs or chicks.

4-5 June 1991: Mist-net captures with storm-petrel vocalizations were conducted at top of the island (20:57-04:00; H.R. Carter, G.J. McChesney, D.L. Whitworth) – one new auklet (#35933) with brood patches was captured and banded at 02:14. No auklet vocalizing was noted.

19-20 July 1991: Mist-net captures with storm-petrel vocalizations were conducted at base of cliff on gravel beach on south side (20:45-05:00; H.R. Carter, D.L. Jory, T. Ingram) – no auklets captured or otherwise noted.

20-21 July 1991: Mist-net captures with storm-petrel vocalizations were conducted at top of the

Appendix 4: Field observations of Cassin's Auklets at Elephant Seal Point and Sutil Island in 1991.

island (20:15-05:00; G.J. McChesney, D.L. Whitworth) – no auklets captured. At 00:11, one auklet flew by. At 01:04, one auklet flew by. At 01:25, one auklet flew in and landed near the banding station and then flew off. At 01:30, one auklet flew in and landed again and then flew back out. Auklet vocalizing was not noted.

20-21 July 1991: Mist-net captures with storm-petrel vocalizations were conducted at base of cliff on gravel beach on south side of the island (20:25-05:05; D.L. Jory, N. Karnovsky, and L. Ochikubo) – no auklets captured or otherwise noted.

Other 1991 Observations

Active Nest Sites

During April, June and October counts of Xantus's Murrelet sites, 31 probably-active Cassin's Auklet sites were found in 8 locations on SBI proper, including: (1) one crevice and three burrows near Graveyard Canyon (area 8); (2) one burrow at Arch Point (area 4); (3) 2 crevices and 1 burrow in area 3; and (4) 13 crevices in the large fissure at Elephant Seal Point and 1 burrow and 9 burrow/crevices in areas on lower Elephant Seal Point (Carter *et al.* 1992).

Mist Nets

Small numbers of auklets were captured in mist nets set to capture storm-petrels at: a) Arch Point on 12-13 April (n = 1 auklet without brood patches at 04:20), 13-14 April (n = 1 auklet without brood patches at 22:56), 19-20 May (n = 1 auklet with brood patches at 02:02), and 20-21 May (n = 1 auklet with brood patches at 03:51); and b) Webster Point on 21-22 May (n = 2 with brood patches at 01:35 and 04:40) (Carter *et al.* 1992; unpubl. field notes).

Comparison between 1991 and 2008-09 Observations

In 1991 and 2008-09, mist-net captures, nocturnal nest searches, and diurnal nest searches were used at two main known SBI breeding areas (Elephant Seal Point and Sutil Island) to document breeding Cassin's Auklets. Evidence of breeding or attendance was found in other areas but was fragmentary and incomplete nest searches were conducted during the breeding season. I have limited my comparisons between 1991 and 2008-09 to Elephant Seal Point and Sutil Island.

At Elephant Seal Point, the same large crevice entrance was examined in 1991 and 2009 but 5 nights of data (3 in April and 2 May) were gathered in 1991 versus 3 nights (one each in April, May, and June) in 2009. At Sutil Island, nest search efforts occurred over all accessible areas of the rock in 1991 and 2008, but was limited to the lower west ledges in 2009 because the top of the island was inaccessible because of breeding Double-crested Cormorants (*Phalacrocorax auritus*) in this area. Mist-net captures at Sutil Island in 1991 occurred mainly on the top of the island and later in the season (*i.e.*, one night in April, none in May, one in June, and two in July). Two nights of mist-net captures also were conducted in July on a gravel beach on the south side. In 2009, diurnal nest searches and one night of mist-net captures were conducted only in April.

Appendix 4: Field observations of Cassin's Auklets at Elephant Seal Point and Sutil Island in 1991.

At Elephant Seal Point in 1991, a total of 17 individuals were captured and banded, six birds were recaptured, and 13 probably-active crevices were recorded. In 2009, 14 auklets were captured and banded and 10 birds were recaptured, similar to 1991. The total number of crevices inside the cave was not determined in 2009 but a few were observed during short attempted entries into the cave and the entrance to the cave appeared similar to 1991 (H.R. Carter, pers. obs.). In both years, small numbers of auklets were heard vocalizing below the net site either in sea caves or on the water, and potential nest sites in the large but narrow fissure could not be counted or inspected. Using mark-recapture analysis (Chapman's modified Lincoln-Petersen) for 1991 data, Carter *et al.* (1992) estimated 26 breeding birds using the fissure, which closely matched the number of probably-active crevices that had been counted if all were active with one breeding pair each. Although capture effort differed between years, numbers of birds captured and recaptured were quite similar in 1991 and 2009 and no evidence of decline was found.

Comparing auklet data at Sutil Island in 2009 with 1991 was more difficult due to greater differences in methods used, areas examined, and overall effort. In 1991, at least 8 auklet nests attended by adults (only one with an egg observed) were found during diurnal nest searches in upper areas on 13 April. Another six sites occupied by adults were noted in burrows (mainly within an area of soil on top of the island) during nocturnal nest searches on the night of 13-14 April. A total of 14 occupied sites were noted on 13-14 April (not 16 as reported in Carter *et al.* 1992). In a mist net placed on the top of the island, nine individual auklets were captured and banded in April-June, none were recaptured, and several other auklets were observed flying by or landing near the net. Auklets were heard vocalizing on the night of 13-14 April but not on the nights of 4-5 June and 20-21 July. Based on an estimate of 81 potential auklet crevices counted in October 1991 and a rough L correction factor of 75% for occupancy, 122 breeding auklets (61 pairs) was roughly estimated for Sutil Island in 1991 (Carter *et al.* 1992).

No auklet nests had been found during diurnal nest searches at Sutil Island on 16-17 May 2008, although nest search efforts occurred primarily on the middle and upper sides of the island. In 2009, one nest and 30 occupied crevices were noted on ledges on the lower west side in April, and 8 birds were captured in mist nets in this area. The top of the island was not searched for nests. The ledges on the lower west side had not been searched in 2008 because of difficult access.

With available information, I could not discern any major difference between numbers of breeding auklets at Sutil Island in 1991 and 2008-09. In October 1991, potential crevices were counted at the ledges on the lower west side (H.R. Carter, pers. obs.) and the estimate of 122 breeding birds for Sutil Island may have accounted for 31 active nests (62 breeding birds) in this area.

Comparison between 1976-77 and 1991 Observations

In 1976-77 and 1991, diurnal nest searches were conducted at Elephant Seal Point and Sutil Island and mist-net captures were conducted at Elephant Seal Point. While a few other nests were found in other areas on SBI proper in 1976-77, their exact locations were not reported. I have limited my comparisons between 1976-77 and 1991 to Elephant Seal Point and Sutil Island because details of nest searches in other areas are not available.

Appendix 4: Field observations of Cassin's Auklets at Elephant Seal Point and Sutil Island in 1991.

At Elephant Seal Point in 1977, 42 auklets were captured with mist nets and banded in the large rock crevice where they burrowed in the "soft dirt floor" (Hunt *et al.* 1979:213-218). A total of 75 pairs (150 breeding birds) were estimated breeding in this cave. The number of mist-net nights and number of recaptures in 1977 was not indicated and I did not consider the nesting habitat to have changed between 1977 and 1991. Overall, I could not discern whether lower numbers of breeding auklets occurred in 1991. However, if a similar mist-net effort did occur in 1977 and many recaptures occurred, then lower numbers likely occurred in 1991. While more birds were captured in 1977 than can be easily accounted for by crevice counts in 1991, many crevices observed in 1991 and 2009 had large enough entrances that several pairs could breed in them, especially if several side chambers developed further inside (H.R. Carter, pers. obs.).

At Sutil Island in 1976, 70 breeding auklets (35 breeding pairs) were estimated, based on one active nest with a chick found in a burrow on top of the island, and with a few other burrows also noted on top and a few more scattered around the island (Hunt *et al.* 1979). With available information, I also could not discern any major difference between numbers of breeding auklets at Sutil Island in 1976 and 1991. It was not clear if the 1976 survey had covered the ledges on the lower west side. However, reduced breeding on the top of the island may have occurred between 1911 and 1976, due to apparent loss of soil on top of the island used for burrowing. A small area of soil deep enough for burrowing was located on top of the island in 1976 and 1991, although few burrows were present (Hunt *et al.* 1979, Carter *et al.* 1992). Nine nests containing eggs with well-developed embryos found on Sutil Island on 14 June 1911 (Willett 1912) likely had been excavated from burrows in this area; this excavation and subsequent weathering likely led to loss of soil over time.